Lenze

Manual

Global Drive

Drive PLC Developer Studio

This Manual is valid for the **Drive PLC Developer Studio V02.00**.

Important note:

The software is supplied to the user as described in this document. Any risks resulting from its quality or use remain the responsibility of the user. The user must provide all safety measures protecting against possible maloperation.

We do not take any liability for direct or indirect damage, e.g. profit loss, order loss or any loss regarding business.

All information given in this online documentation has been carefully selected and tested for compliance with the hardware and software described. Nevertheless, discrepancies cannot be ruled out. We do not accept any responsibility or liability for any damage that may occur. Any corrections required will be implemented in subsequent editions.

Version 2.3 01/2005

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1 Preface and general information

1.1 About this manual

This Manual offers detailed information on the **Drive PLC Developer Studio** (**DDS**).

The Drive PLC Developer Studio is a powerful development environment for your PLC programs on Lenze IEC 61131 systems.

The Drive PLC Developer Studio utilizes the powerful IEC language tools, offering individual editors for the six IEC 61131-3 languages as well as commissioning support through monitoring and debugging functions. The Drive PLC Developer Studio provides all the comfort and ease of fully matured development environments offered by higher-level programming languages under Windows.

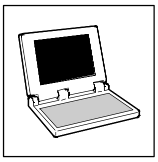
1.1.1 Terminology used

Term	**In the following text used for**
DDS	Drive PLC Developer Studio
GDC	Global Drive Control (parameter setting program for Lenze PLCs/Lenze automation systems)
GDO	Global Drive Oscilloscope (for servo PLC devices)
SB	System block
FB	Function block
Parameter codes	Codes for setting the functionality of function blocks

1.2 Applied conventions

This Manual applies the following conventions to distinguish between different types of information:

Type of information	**Print**	**Example**
Names of dialog boxes, input fields and selection lists	*italics*	The dialog box *Options*
Buttons	**bold**	Click **OK** to...
Menu commands	**bold**	Use the command **Messages** to ...
		If the execution of a function requires several commands, the individual commands are separated by an arrow: Select **File→Open** to...
Keyboard commands	**<fett>**	Use **<F2>** to open the Help Manager.
		If a command requires a combination of keys, a "+" is placed between the key symbols: Use **<Shift>+<ESC>** to ...
Program listings	`Courier`	`IF var1 < var2 THEN...`
Keywords	**`Courier bold`**	...starts with **`FUNCTION`** and ends with **`END FUNCTION`**.
Important note	⚠	**Caution!** Do not use the command **Online→Controller inhibit** for an emergency stop through the PC since this command reaches the controller with a time delay.
Tip	ℹ	**TIP!** Positioning the mouse pointer briefly over an icon in the tool bar will display a "tool tip" with the associated command.



Drive PLC Developer Studio

Preface and general information

2 Introduction

2.1 Function overview

Project structure

The project is saved in a file that is named after the project.

The first organization unit created in the new project is automatically called `PLC_PRG`. Other organization units (programs, function blocks and functions) can be called from here.

The DDS uses the Object Organizer to differentiate between the different object types within a project:

- Organization units
- Data types
- Visualization elements (visualization)
- Resources.

The *Object Organizer* allows fast access to all objects of your project. Resource structuring uses the following objects, among others:

- Libraries
- Codes
- Task configurations
- etc.

Project generation

Addresses not included in the PLC configuration cannot be used.

First configure the control to facilitate access to the system organization units during programming.

Then generate the organization units required for your application, or copy them from existing projects. Program the required organization units in the desired language.

On completion of the programming process, compile the project and eliminate any reported errors.

Simulation with the DDS

Once all errors have been eliminated, activate the simulation, log in to the simulated control and start the project. The DDS is now in online mode.

The window with the PLC configuration can now be opened, and the project can be checked for correct operation. For this purpose, assign the inputs manually and check that the outputs are set as required. The organization units also allow a monitoring of local variable current values. Use the Watch and Receipt Manager to configure the data records to be monitored.

Note!

Lenze function blocks are not simulated.

Simulation is generally restricted. (📖 6-37)

Debugging with the DDS

In the event of a programming error, breakpoints can be set. If program execution stops at a breakpoint, the values of all project variables as at that time can be inspected. Logical correctness of the program can be checked by step-by-step processing (single-stepping).

Program variables and inputs / outputs can be set to specific values.

Project documentation using the DDS

The entire project can be documented or exported to a text file at any time.

2.2 Project components

2.2.1 Project

A project includes all objects of a control program. Links with the libraries are saved in a file bearing the project name.

A project includes the following objects that can be accessed via the Object Organizer:

- Organization units
- Data types
- Visualizations
- Resources
  – Libraries
  – Codes

2.2.2 Organization unit (POU)

Functions, function blocks and programs are organization units of a project and referred to as program organization units (POU) in the
IEC 61131 programming language.

Every organization unit consists of a declaration part and a body. The body is written in one of the IEC programming languages (IL, ST, SFC, FBD, LD or CFC).

The DDS supports all IEC standard organization units as well as Lenze-specific organization units. Use of these organization units in your project requires the associated function library to be linked to your project with the help of the Library Manager.

Organization units can call other organization units. Recursions cause a compiler error and must be avoided.

2.2.3 Function

A function is a software organization unit that returns exactly one data element (that may also consist of several elements such as fields or structures, for example) on execution and whose call may occur in textual languages as an operator in expressions.

Note when declaring a function that a type must be assigned to the function, i.e. the function name must be followed by a colon plus type.

The names of function and function output are identical.

Example of a correct function declaration:

```
FUNCTION Fct: INT
```

- A function declaration starts with the keyword **`FUNCTION`**.
- A result must be assigned to the function, i.e. the function name is used like an output variable.
- In ST, a function call may occur as an operand in expressions.
- Functions cannot save their internal statuses. Function calls using the same input parameters always return the same value.
- No functions can be programmed in SFC.

Function CheckBounds

Tip!

Definition of a function with the name `CheckBounds` in your project will automatically check whether the boundaries have been exceeded on access to an array in your project! (refer example below).
Also refer the Checkbound library (Checkbound.lib).

The function name is defined and must not be changed.

```
CheckBounds (FUN-ST)
0008    lower: BOOL;
0009    upper: BOOL;
0010    index: BOOL;
0011    CheckBound: BOOL;

0001 IF index < lower THEN
0002 CheckBounds := lower;
0003 ELSIF index > upper THEN
0004 CheckBound := upper;
0005 ELSE
0006 CheckBound := index;
0007 END_IF
0008
```

The following program example to test the **CheckBounds** function corrects access outside defined array boundaries.

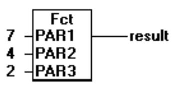
```
PLC_PRG (PRG-ST)
0001 PROGRAM PLC_PRG
0002 VAR
0003    A:ARRAY[0..7] OF BOOL;
0004    B:INT:=10;

0004
0005 A[B]:=TRUE;
0006
```

The function **CheckBounds** ensures that the value **`TRUE`** is not assigned to position `A[10]`, but to the upper permissible range limit `A[7]`.

Use the function **CheckBounds** to correct accesses outside array boundaries.

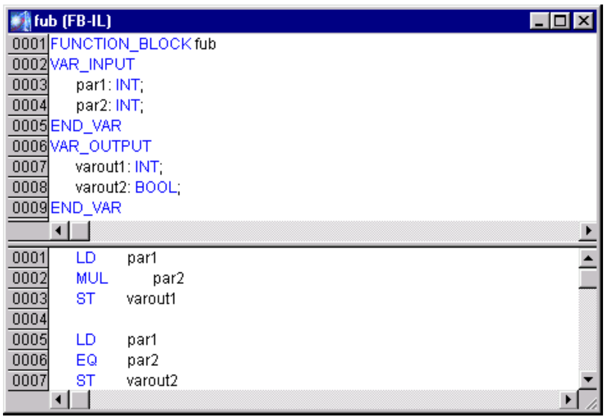
2.2.3.1 Example of a function

Example of a function in IL:	Example of the function call of the function shown on the left:
Fct (FUN-IL) 0001 FUNCTION Fct : INT 0002 VAR_INPUT 0003 END_VAR 0004 VAR 0005 PAR1: INT; 0006 PAR2: INT; 0007 PAR3: INT; 0008 END_VAR 0001 LD PAR1 0002 MUL PAR2 0003 DIV PAR3 0004 ST Fct	**IL** `LD 7` `Fct 4,2` `ST result` **ST** `result := Fct(7, 4, 2);` **FBD** 

2.2.4 Function block

A function block is a software organization unit whose execution returns one or several values.

- Unlike a function, a function block does not supply a return value.
- A function block declaration starts with the keyword **`FUNCTION_BLOCK`**.
- The creation of instances (data records) of a function block is a prerequisite.



2.2.4.1 Function block instances

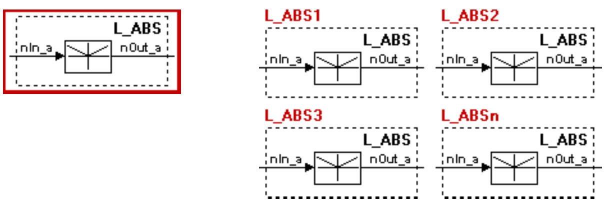
- Every instance has its own identifier (instance name) and a data structure which includes its inputs, outputs and internal variables.
- Instances are locally or globally declared like variables by giving the function block name as identifier type.

Example of an instance named INSTANZ of function block FUB:

```
INSTANZ: FUB;
```

- The instances described above are always used to call function blocks.
- Only input and output parameters can be accessed from outside an instance of a function block, not its internal variables.

Example with the help of a data model:

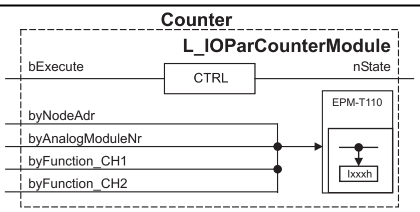


Instances `L_ABS1` ... `L_ABSn` are instances of the function block type **`L_ABS`**. Instance as many instances as required.

Example of access to an input variable:

```
(* The function block fb has an input variable in1 of type int. *)
PROGRAM prog
VAR
 inst1:fb;
END_VAR
 LD 17
 ST inst1.in1
 CAL inst1
END_PROGRAM
```

- The declaration parts of function blocks and programs may contain instance declarations. Instance declarations are not allowed in functions. A function cannot call a function block.
- Access to the instance of a function block is restricted to the organization unit in which it was instanced, unless it was globally declared. Function blocks should never be globally declared as this would lead to logical errors.
- The instance name of a function block may be used as input for a function or a function block.




```
PROGRAM Counter
VAR
 Counter: DINT;
END_VAR
```

Counter is the instance name of function block **L_IOParCounterModule** and can be used as input in the code.

Note!

All values remain the same from one execution of the function block to the next. Therefore function block calls with the same arguments do not necessarily return the same output values!

Should the function block include at least one Retain variable, the whole instance is stored in the Retain area.

2.2.4.2 Calling a function block

The input and output variables of a function block can be approached by another organization unit. For this purpose, a function block instance must be generated and the desired variable specified with the help of the following syntax:

```
<Instance name>.<Variable name>
```

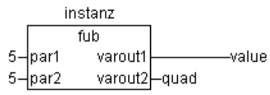
Input writes only

Input and output reads

- To set the input parameters on call in the IL and ST text languages, assign values to the parameters in brackets after the function block instance name (assignment via `:=` as for the initialization of variables at the point of declaration).

Tip!

SFC allows function block calls in steps only.

Declaration part:		Instruction part:
`PROGRAM test` `VAR` ` quad: BOOL;` ` instanz: fub;` ` value: INT:=0;` `END_VAR`	**IL**	`CAL instanz(par1:=5,par2:=5)` `LD instanz.varout2` `ST quad` `LD instanz.varout1` `ST value`
	ST	`instanz(par1:=5,par2:=5);` `quad:=instanz.varout2;` `value:=instanz.varout1;`
	FBD	

2.2.5 Program

A program is an organization unit that returns one or several values on execution.

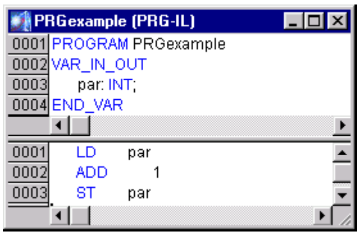
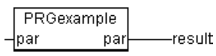
- A program declaration starts with the keyword **`PROGRAM`**.
- Programs are known globally throughout the entire project.
- Programs can be called by programs and function blocks. Program calls in a function are not allowed. Programs do not have instances.
- If an organization unit calls a program, thus changing program values, these changes remain active for the next program call, even if the program is called by another organization unit.

Tip!

Only the values in the associated instance of a function block are changed on function block call.

These changes are significant only if the same instance is called.

2.2.5.1 Program example

Example of a program in IL:		Examples of calling the program shown on the left:
	**IL**	`CAL PRGexample` `LD PRGexample.par` `ST result`
	ST	`PRGexample;` `result:=PRGexample.par;`
	FBD	

Example of a possible call sequence from a main program:

```
LD 0
ST PRGexample.par (* par is preset with 0 *)
CAL AWLexample (* result in AWLexample = 1 *)
CAL STexample (* result in STexample = 2 *)
CAL FUPexample (* result in FUPexample = 3 *)
```

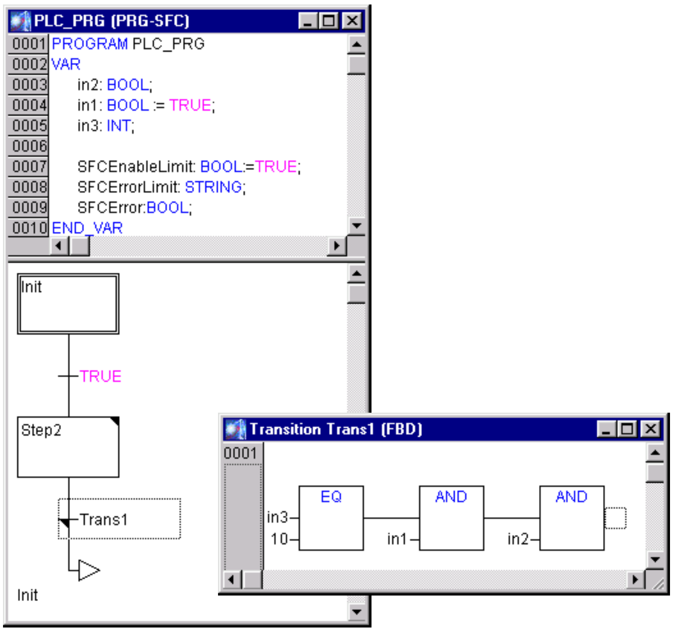
- If the variable `par` of the program `PRGexample` is initialized with 0 from the main program, and programs are then called successively by means of the above program calls, the `result` will have the values 1, 2, and 3 in the programs.
- Changing the call sequence will also change the values of the associated result parameters.

Note!

The string length is limited by the applied automation system.

Restrictions occur through limited lengths in the string routines. Only 20 characters can be processed before the string is cut.

The example below illustrates the restriction in online mode.



2.2.6 PLC_PRG

`PLC_PRG` is a special predefined organization unit for a cyclical task. This organization unit is called exactly once per control cycle.

- If **Project→Insert object** is run for the first time after a new project has been created, the dialog box *Organization unit* is pre-assigned with an organization unit called `PLC_PRG` of type Program. This pre-assignment should not be changed!

Caution!

Do not delete or rename the organization unit `PLC_PRG` if you do not use a task configuration. Do not attach PLC_PRG to an already created task as PLC_PRG will then be called several times, leading to logical errors.

`PLC_PRG` is generally the main program in a single task program.

2.2.7 System POUs

System POUs are hardware-dependent POUs (program organization units) with special functions which are provided by the associated PLC (e.g. 9300 Servo PLC, Drive PLC). (Also refer associated PLC manual)

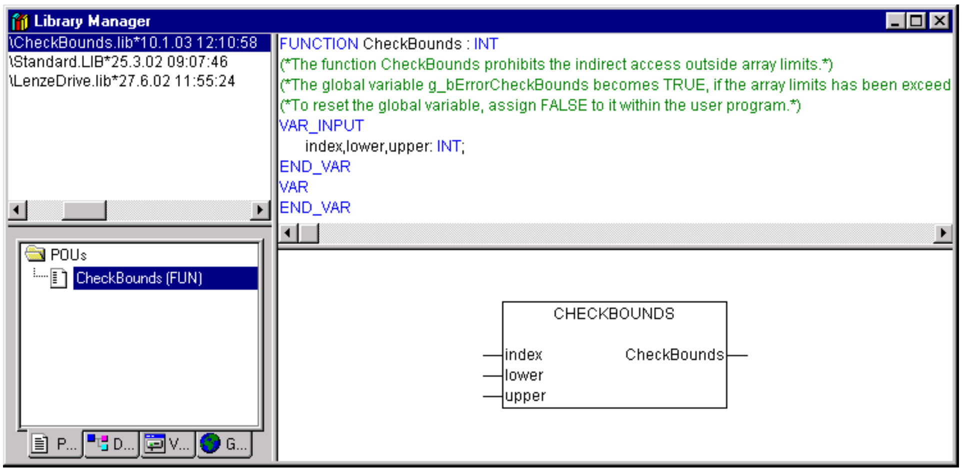
2.2.8 Resources

Resources are required to configure and organize your project and to trace variable values:

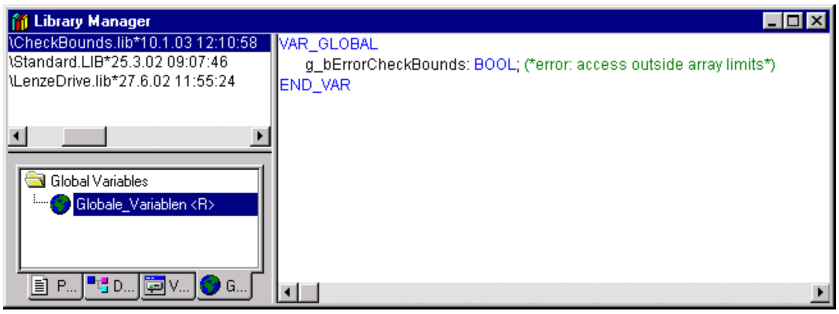
- Global variables to be used throughout the entire project.
- PLC configuration to configure your hardware.
- Task configuration to control your program through tasks.
- Task monitoring to monitor the task runtimes.
- Watch and Receipt Manager to display and pre-assign variable values
- Automation system settings for selection and, if appropriate, for final configuration of the automation system

2.2.9 Libraries

The Library Manager can link your project to several libraries whose organization units, data types and global variables can be used in addition to the user-defined ones.



The register card Global Variables contains the variable *g_ErrorCheckBounds*.



Depending on the selected PLC, some libraries are automatically linked when a new project is created (the library ”standard.lib”, for example).

2.2.10 Data types

In addition to the standard data types, users can define some data types of their own. Structures, enumeration types and references can be created.

2.2.11 Visualization

The DDS provides visualization to monitor and modify project variables.

The visualization allows offline drawing of geometrical elements that can then change their shape/colour/text output online, depending on certain variable values.

2.3 Debugging, online functionality

2.3.1 Debugging

The DDS debugging functions assist troubleshooting.

- To allow debugging, go to dialog box *Options*, category *Build options* and tick check box **Debugging**.

Note!

The check box **Debugging** should be ticked for debugging only.

Breakpoint on, Single step or Single cycle are possible only if Debugging is active.

2.3.2 Breakpoint

A breakpoint is a point in the program where processing stops.

- Breakpoints enable the user to look at variable values at a certain program location.
- Breakpoints can be set in all editors. In the text editors, breakpoints are set to line numbers, in FBD and LD to network numbers, in CFC to organization units, and in SFC to steps.
- Breakpoints may be set in the implementation of an initialized function block. No breakpoints may be set in function block instances.

2.3.3 Single step

Single step means in:

- IL: Execute program to next `CAL`, `LD` or `JMP` command.
- ST: Execute next instruction.
- FBD, LD: Execute next network.
- SFC: Execute action to next step.
- CFC: Execute next organization unit (box) in the CFC program.

The logical correctness of a program can be checked by step-by-step processing.

2.3.4 Single cycle

Selection of Single cycle will stop processing after every cycle.

Caution!

If a breakpoint is set, the use of tasks will lose the real-time response. A 1ms-cycle task will no longer be started every millisecond.
If breakpoints are set, all tasks will be started one after the other after the main program PLC_PRG has been processed. Event-controlled tasks will be started upon a valid start event only.
This, among other aspects, influences the functionality of the generated overall project.

2.3.5 Changing values online

Variables can be set once-only to a specific value during operation after the command Write values was transmitted to the control. The value of a variable can also be changed online by simply double-clicking it. Boolean variables thus change from **TRUE** to **FALSE** and viceversa. For the other variables, the system will display a dialog box *Write variable xy* to edit the variable value.

2.3.6 Monitoring

In online mode, the current values for all variables displayed on screen will be continuously read from the control and displayed. Refer declaration and program editor for this display.

Current variable values may be output in the Watch and Receipt Manager and in a visualization.

The display and monitoring of variables from function block instances requires the associated instance to be opened.

The implementations show the pointer value. The dereferenced value is shown for dereferenced variables.

Monitoring VAR_IN_OUT variables

When monitoring VAR_IN_OUT variables, the de-referenced value is output in the declaration part and the program part.

Monitoring Pointers

Warning!

Monitoring of de-referenced pointer values is not supported by all Lenze target systems.

In online mode, it depends on the target system which de-referenced pointer values (pointer variable^) are indicated.

Some Lenze target systems indicate the pointer value itself.

During monitoring the pointer and the de-referenced value are output in the declaration part. In the program part, only the pointer is output.

```
pointervariable= <pointer value>

Pt= <value>
```

The value of the pointer is indicated in the implementations, whereas in the case of de-referencing only the de-referenced value is indicated.

Monitoring ARRAY components

The following components are displayed:

- Array components indexed via a constant. `anarray[1] = 5`

The following components are not displayed:

- Array components with extended index. `anarray[i+j] = 5` or `anarray[i+1] = 5`

2.3.7 Simulation

During a simulation on the processor, the generated control program will be processed together with the DDS, offering complete online functionality. The logical correctness of the program can be tested to a limited extent only without control hardware. (🕮 6-37)

2.3.8 Log

The log records user actions, internal processes, status changes and exceptions chronologically in online mode and serves monitoring and error tracing. (🕮 6-42)

3 Program example "Traffic light"

3.1 Introduction

This chapter includes a program tutorial for an easier start with the DDS.

The setup calls for the programming of a mini traffic control system for two traffic lights at an intersection.

- Both traffic lights will alternate their red/green phases.
- To avoid accidents, the traffic lights will also include amber and amber/red between the red and green phases, with the amber/red phase being shorter than the amber phase.

This example illustrates

- how to implement time-controlled programs using IEC 61131-3 language tools.
- how to edit the various standard languages using the DDS.
- how to link the different languages.
- how to simulate a program in the DDS and visualize it on screen.

3.2 Programming

3.2.1 Starting the DDS

1. In the Windows **Start menu**, select submenu **Programs→Lenze→Drive PLC Developer Studio** and click **Drive PLC Developer Studio** to start the DDS.

Tip!

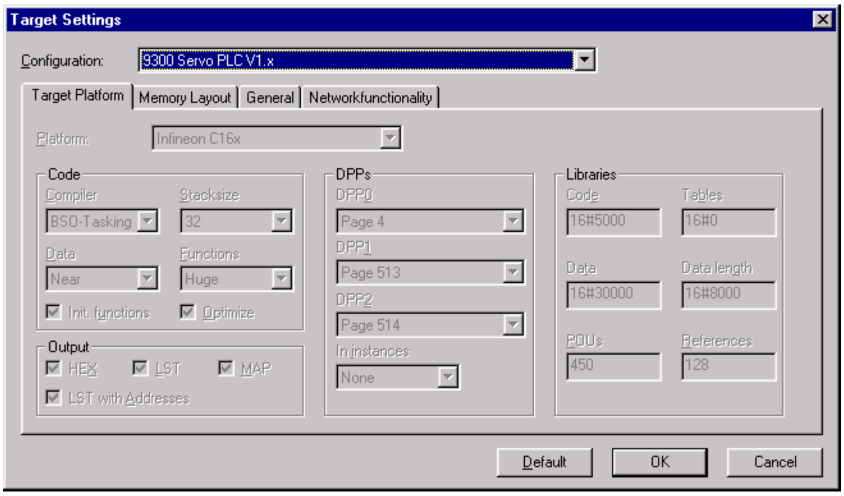
If under **Project→Options**, category *Load & Save*, the check box **Automatic loading** is selected, the project last edited is opened automatically on DDS start.

3.2.2 Creating a new project

2. Select **File→New** to create a new project.

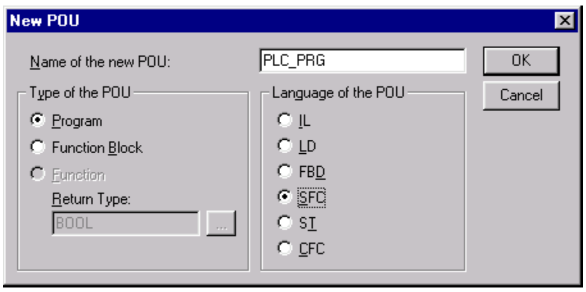
3.2.3 Selecting PLC

3. Open dialog box *Automation system settings* and select a PLC from the combination box **Configuration** (e. g. the **9300 Servo PLC**) and confirm with **OK**:



3.2.4 Creating organization units

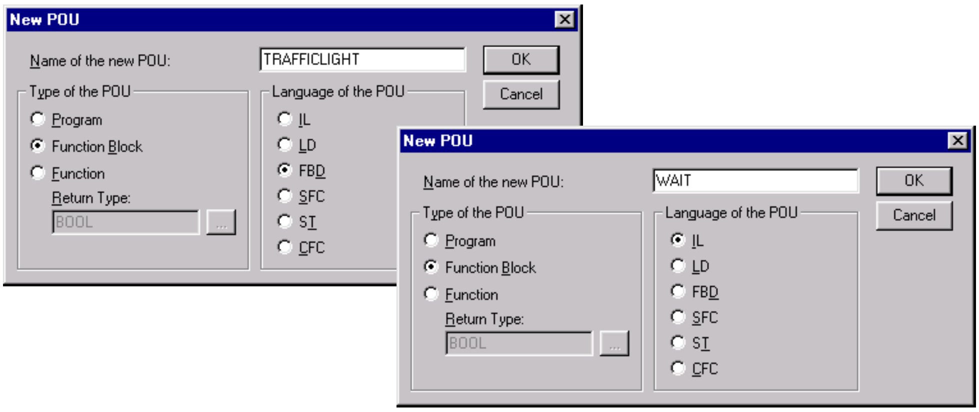
4. The dialog box *New POU* already displays the name of the first organization unit as `PLC_PRG`; do not change name and type of the organization unit (Program).



Tip!

Only the organization unit named **`PLC_PRG`** of type "Program" will be processed by the cyclical task. The cyclical task does not need to be explicitly created.

5. Select **Sequential function chart (SFC)** as the language for this organization unit and confirm with **OK**.
6. Now create two further objects in the *Object Organizer* on tab *Organization units* with the help of **Project→Object→Insert**:
   – **TRAFFICLIGHT** type **Function block** in the language **Function block diagram (FBD)**
   – **WAIT** type **Function block** in the language **Instruction list (IL)**



TRAFFICLIGHT

In the organization unit **TRAFFICLIGHT**, the individual light phases will be assigned to the traffic lights, i. e., the red light will be on during the red and amber/red phases, the amber light will be on during the amber and amber/red phases, etc.

WAIT

In the organization unit **WAIT**, a simple timer will be programmed to receive as input the phase duration in milliseconds and to return an output **`TRUE`** as soon as the time has expired.

PLC_PRG

The organization unit **`PLC_PRG`** links the organization units with each other so that the traffic light emits the correct colour at the correct time and for the specified time. It processes the entire project during the cyclical task.

3.2.5 The organization unit TRAFFICLIGHT

7. To edit the organization unit **TRAFFICLIGHT**, activate its editor window by selecting *Object Organizer*, tab *Organization units* and double-clicking **TRAFFICLIGHT**.

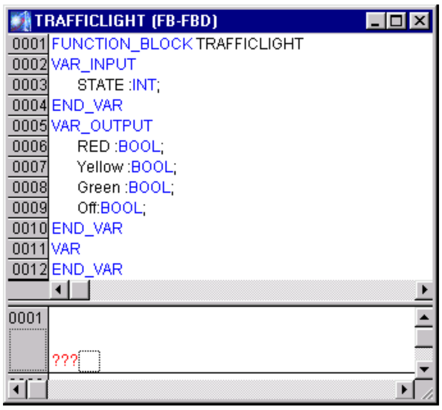
3.2.5.1 Declaration

8. In the declaration editor, declare
   – as input variable (between the keywords **`VAR_INPUT`** and **`END_VAR`**) a variable named `STATE` of type **`INT`**.
   – as output variables (between the keywords **`VAR_OUTPUT`** and **`END_VAR`**) the variables `RED`, `AMBER`, `GREEN` and `OFF` of type **`BOOL`**.

The status of the variable `STATE` is used to switch the output variables for the associated light colour:

Traffic light phase	Input variable	Output variables			
	STATE	RED	AMBER	GREEN	OFF
Green	1	FALSE	FALSE	TRUE	FALSE
Amber	2	FALSE	TRUE	FALSE	FALSE
Red	3	TRUE	FALSE	FALSE	FALSE
Amber/red	4	TRUE	TRUE	FALSE	FALSE
Off	5	FALSE	FALSE	FALSE	TRUE

The declaration part of the function block **TRAFFICLIGHT** now looks as follows:

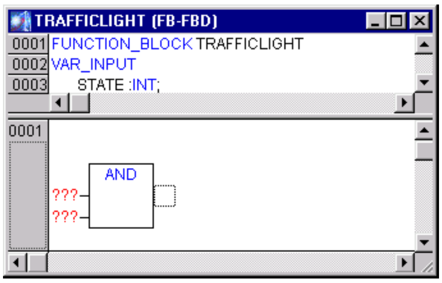


3.2.5.2 Function block diagram

Now use the input variable `STATE` of the organization unit to determine the values of the output variables.

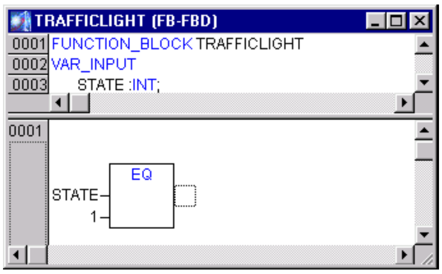
9. In the lower half of the editor window for the organization unit **TRAFFICLIGHT**, click the field to the left of the first network (grey field with number 1) to select the network.
10. Select **Insert→Operator**.

A box with the operator **AND** and two inputs is inserted in the first network:



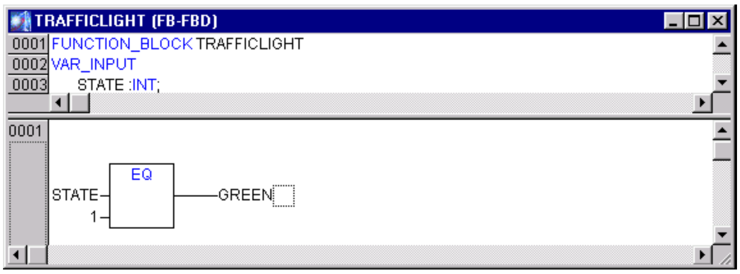
11. Click “AND” and change the text to “EQ”.
12. Select the text “???” of the upper input and enter the variable `STATE` .
13. Select the three bottom question marks and name the input 1.

14. Click behind the EQ box to select the output.



15. Select **Insert→Assignment**.

16. Change the text “???” at the output to “GREEN”.



- `STATE` is compared to 1. If the result is TRUE, `GREEN` will be assigned. This network will switch the traffic light to green if the status value input is 1.

The other traffic light colours `RED`, `AMBER` and `OFF` require three more networks.

17. Select **Insert→Network (after)** to create a new network.

18. Select **Insert→Operator**.

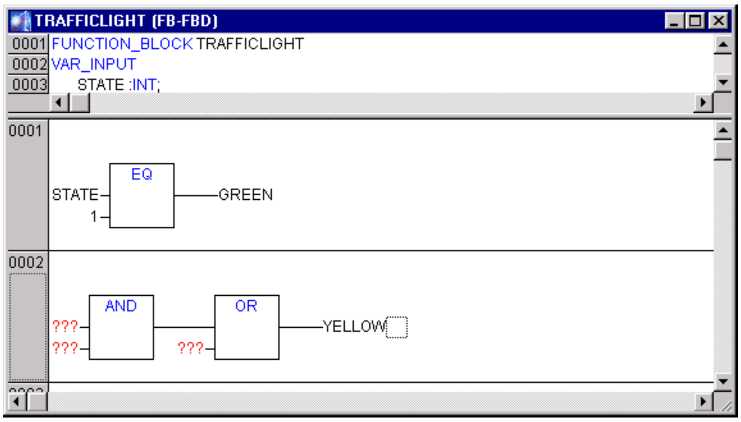
19. Click “AND” and change the text to “OR”.

20. Click behind the OR box to select the output.

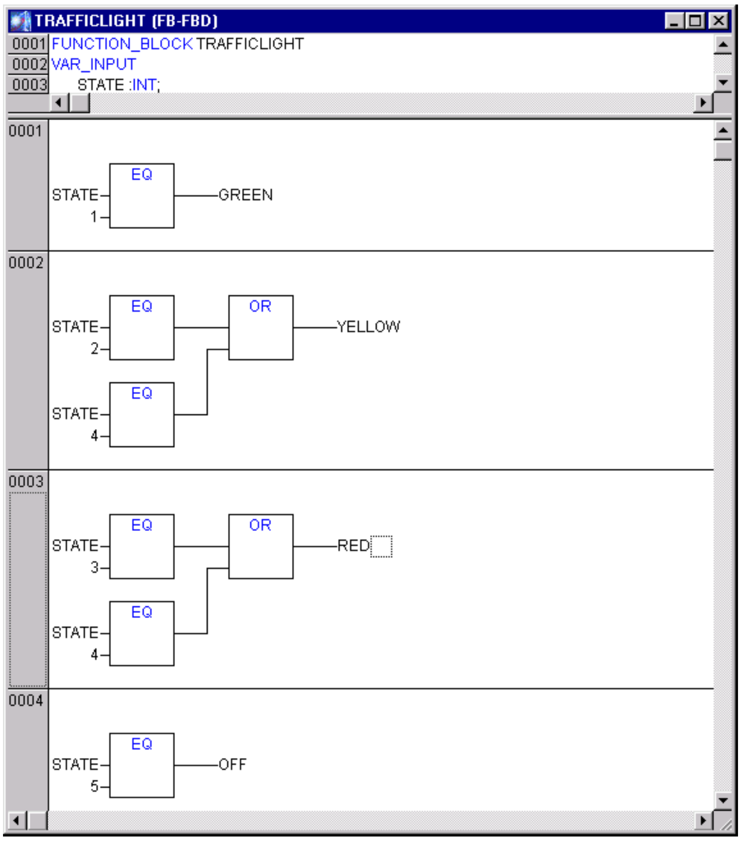
21. Select **Insert→Assignment**.

22. Change the text “???” at the output to “AMBER”.

23. Select the upper input of the OR box and then **Insert→Operator** to insert another operator before the selected input.



24. Use the above procedures and commands to complete the organization unit as follows:



The first organization unit is complete. **TRAFFICLIGHT** controls the traffic light colours depending on the input of value `STATE`.

3.2.6 The organization unit WAIT

The organization unit **WAIT** is to be a timer to control the duration of the different traffic light phases.

25. To edit the organization unit **WAIT**, activate its editor window by selecting *Object Organizer,* tab *Organization units* and double-clicking **WAIT**.

3.2.6.1 Declaration

26. In the declaration editor, declare
    – as input variable (between the keywords **`VAR_INPUT`** and **`END_VAR`**) a variable named `SETTIME` of type **`TIME`**.
    – as output variable (between the keywords **`VAR_OUTPUT`** and **`END_VAR`**) a variable named `OK` of type **`BOOL`**.
27. Pre-assign the output variable `OK` with **`FALSE`** by inserting ":=FALSE" at the end of the declaration (but before the ;).

The output variable `OK` is to output the value **`TRUE`** as soon as the time specified with `SETTIME` has expired. For this function use the organization unit **`TP`**, a pulse encoder.

Pulse encoder TP

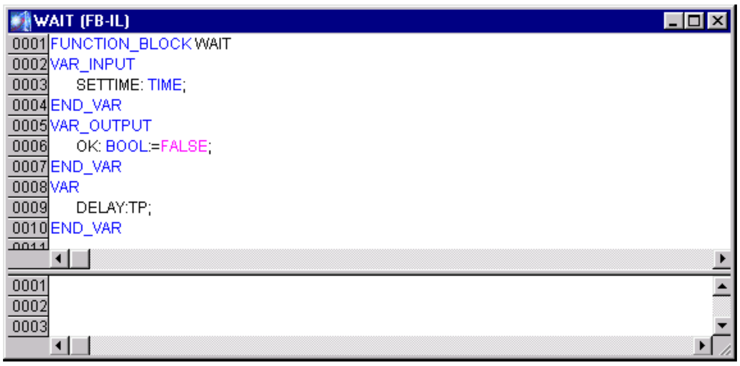
The pulse encoder **TP** has two inputs (`IN`, `PT`) and two outputs (`Q`, `ET`).

- If at the input `IN` **TRUE** is applied, the output `Q` , for the time `PT` (in milliseconds) will return the value **TRUE**.
- `ET` outputs the time already expired in milliseconds.

Input variable	Status	Output variables	Status/value
IN	FALSE	Q	FALSE
		ET	0
IN (ET < PT)	TRUE	Q	TRUE
		ET	0 ➚ PT*
IN (ET = PT)		Q	FALSE
		ET	PT
* The output ET counts the time in milliseconds.			

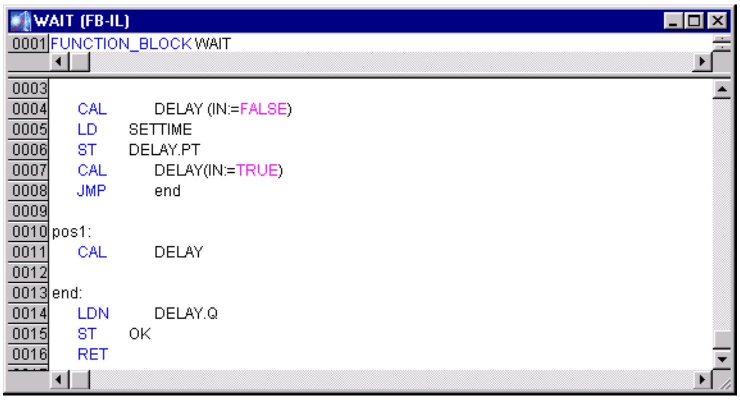
To use the pulse encoder **TP** in the organization unit **WAIT** we must create a local instance of **TP** :

28. Use the declaration editor to declare as local variable (between the keywords **VAR** and **END_VAR**) a variable named `DELAY` of type **TP**.



3.2.6.2 Instruction list

To implement the timer, the instruction list for the organization unit **WAIT** must be as follows:



Process

The first interrogation establishes whether `Q` is already set to **`TRUE`** (**`TRUE`**: timer running). [*Line 1*]

- If `Q is` **`TRUE`**, we will not change the assignment of `DELAY` but instead call function block `DELAY` without input (to check whether the time has already expired). [*Line 10*]
- If `Q is` **`FALSE`**, we will set the variable `IN` in `DELAY` to **`FALSE`** and thus at the same time `ET` to 0 and `Q` to **`FALSE`**. [*Line 4*]
  All variables are now set to the desired initial status.
  – Now save the time required from variable `SETTIME` in variable `PT` [*Line 5/6*], and call `DELAY` with `IN:=` **`TRUE`**. [*Line 7*]
  – In the function block `DELAY` , the variable `ET` will now be counted up until it reaches the value `SETTIME` ; then `Q` will be switched to **`FALSE`** .
- The negated value of `Q` will be saved after every **WAIT** cycle in `OK` [*Line 14/15*]
- As soon as `Q becomes` **`FALSE`**, `OK becomes` **`TRUE`**.

The timer is complete.

3.2.7 The main program PLC_PRG

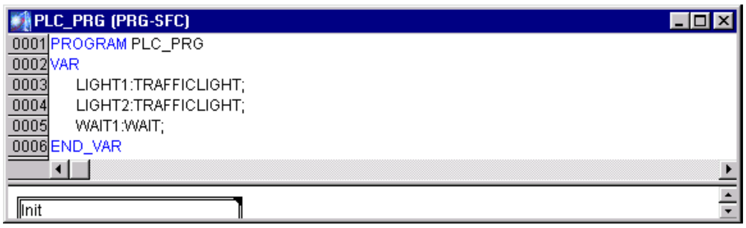
The organization unit **`PLC_PRG`** is the main program for calling the two function blocks **WAIT** and **TRAFFICLIGHT** .

29. To edit the organization unit **`PLC_PRG`**, activate its editor window by selecting *Object Organizer,* tab *Organization units* and double-clicking **`PLC_PRG`** .

3.2.7.1 Declaration

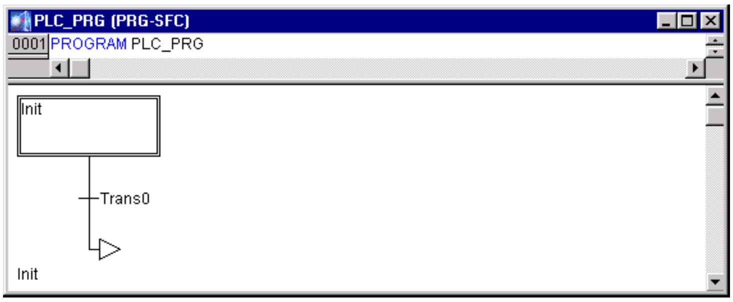
To ensure that the function blocks created before can be used in **`PLC_PRG`**, it is necessary to declare instances of these function blocks. The traffic light example requires two instances of the function block **TRAFFICLIGHT** (**LIGHT1**, **LIGHT2**) and one instance of the function block **WAIT** (**WAIT1**).

30. Use the declaration editor to declare as local variable (between the keywords **`VAR`** and **`END_VAR`**) the variables for the required instances.



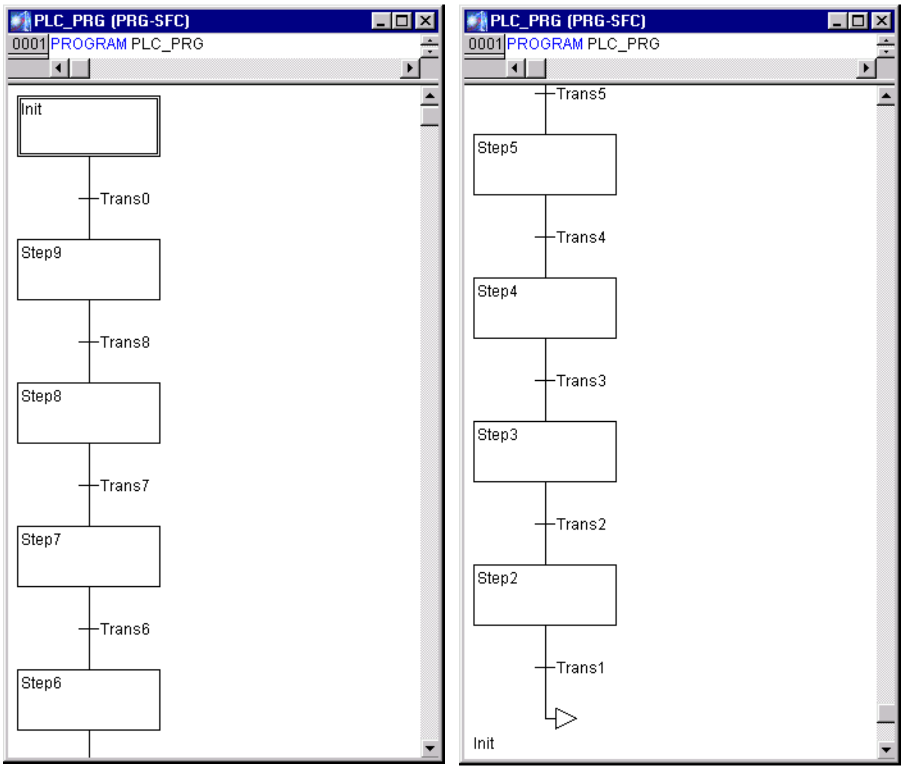
3.2.7.2 Sequential function chart

The start-up diagram of an organization unit in SFC always consists of an action **Init**, a subsequent transition **Trans0** and a jump back to **Init**.



The traffic light example requires a step for every traffic light phase.

31. Select the transition **Trans0** (click the horizontal line to the left of **Trans0**) to frame it with a dotted line.
32. Select **Insert→Step transition (after)** to insert a step transition after **Trans0**.
33. Repeat the above step seven times to create the following sequential function chart:
    – To delete a step or transition, select the step and the associated transition, otherwise they cannot be deleted.
    – First click the step, press **<Shift>**, then click the transition.



- Clicking the name of a transition or step directly will invert the text for editing.

34. Change the name of the first transition after Init to `TRUE`.
35. Change the names of all subsequent transitions to "WAIT1.OK".

- The first transition switches all the time, all other transitions when **WAIT1** in **OK becomes** `TRUE` , i.e. when the specified time has expired.

36. Change the names of the steps as described below (from top to bottom):
    – Init (remains unchanged)
    – CHANGE1
    – GREEN1
    – CHANGE2
    – RED1
    – CHANGE3
    – GREEN2
    – CHANGE4
    – RED2

- "CHANGEx" stands for a amber phase each time, "GREEN1" means that traffic light 1 will be green and "GREEN2" applies for traffic light 2, "RED1" means that traffic light 1 will be red and "RED2" applies for traffic light 2.

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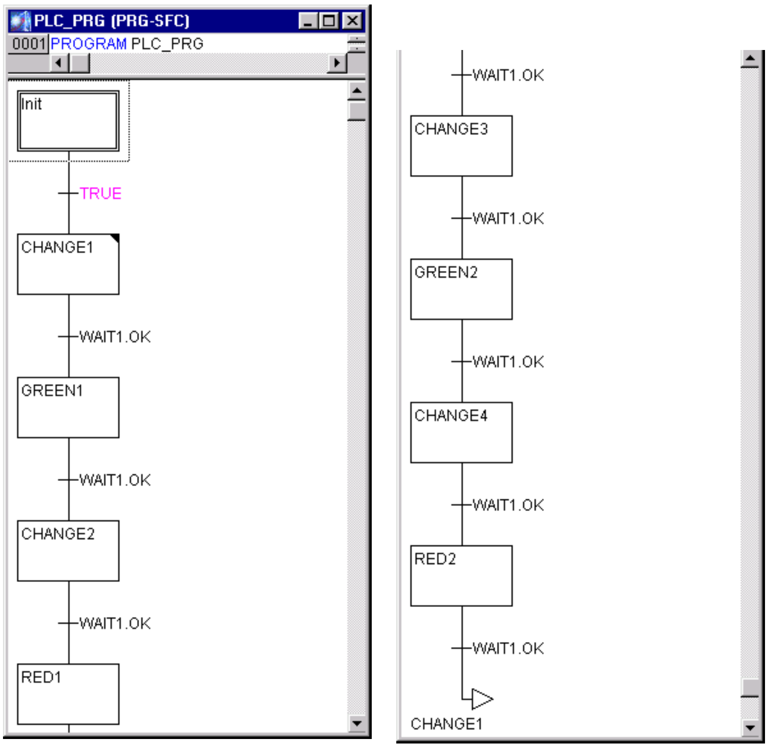
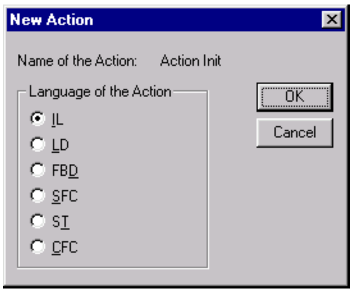
37. Change the return jump address (underneath the arrow) from “Init” to “CHANGE1” to create the following sequential function chart:



Now the individual steps must be programmed.

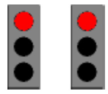
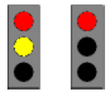
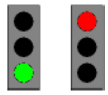
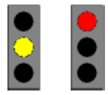
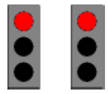
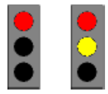
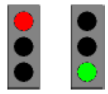
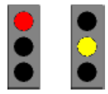
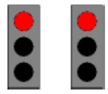
- Double-clicking a step field will open a dialog box to create a new action.
- We will use IL throughout our example.

38. Double-click the step “Init” to open the dialog box *New action*.



39. Select IL as the language for the action and confirm with **OK**.

40. Enter the following actions for the step “Init” into the editor window and define the actions for the other steps in the same way.

Step	Actions	Status Light1/Light2
Init	`CAL LIGHT1(STATE:=3)` `CAL LIGHT2(STATE:=3)`	
CHANGE1	`CAL LIGHT1(STATE:=4)` `CAL LIGHT2(STATE:=3)` `CAL WAIT1(SETTIME:=t#2s)`	
GREEN1	`CAL LIGHT1(STATE:=1)` `CAL LIGHT2(STATE:=3)` `CAL WAIT1(SETTIME:=t#5s)`	
CHANGE2	`CAL LIGHT1(STATE:=2)` `CAL LIGHT2(STATE:=3)` `CAL WAIT1(SETTIME:=t#2s)`	
RED1	`CAL LIGHT1(STATE:=3)` `CAL LIGHT2(STATE:=3)` `CAL WAIT1(SETTIME:=t#1s)`	
CHANGE3	`CAL LIGHT1(STATE:=3)` `CAL LIGHT2(STATE:=4)` `CAL WAIT1(SETTIME:=t#2s)`	
GREEN2	`CAL LIGHT1(STATE:=3)` `CAL LIGHT2(STATE:=1)` `CAL WAIT1(SETTIME:=t#5s)`	
CHANGE4	`CAL LIGHT1(STATE:=3)` `CAL LIGHT2(STATE:=2)` `CAL WAIT1(SETTIME:=t#2s)`	
RED2	`CAL LIGHT1(STATE:=3)` `CAL LIGHT2(STATE:=3)` `CAL WAIT1(SETTIME:=t#1s)`	

This completes the first phase of our program. You can now compile the program and test it in a simulation.

3.2.8 Extending the program with an alternative branch

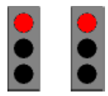
To include at least one alternative branch in our chart so that we can turn the traffic lights off over night, we will include a counter to deactivate the system after a specific number of traffic light cycles.

Firstly, we will need a new variable `COUNTER` of type **`INT`**.

41. To edit the organization unit **`PLC_PRG`**, activate its editor window by selecting *Object Organizer*, tab *Organization units* and double-clicking **`PLC_PRG`** .

42. Use the declaration editor to declare as local variable (between the keywords **`VAR`** and **`END_VAR`**) the variable `COUNTER` of type **`INT`**.

43. Initialize the variable `COUNTER` in the step “Init” with 0:

Step	Actions	Status Light1/Light2
Init	`CAL LIGHT1(STATE:=3)` `CAL LIGHT2(STATE:=3)` `LD 0` `ST COUNTER`	

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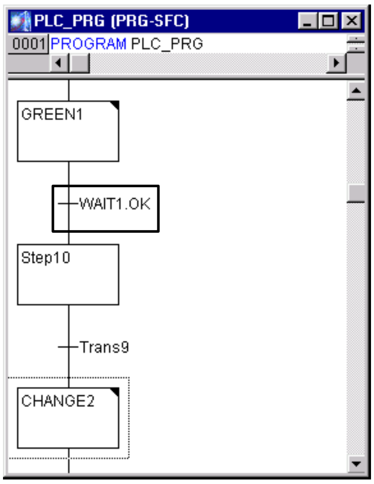
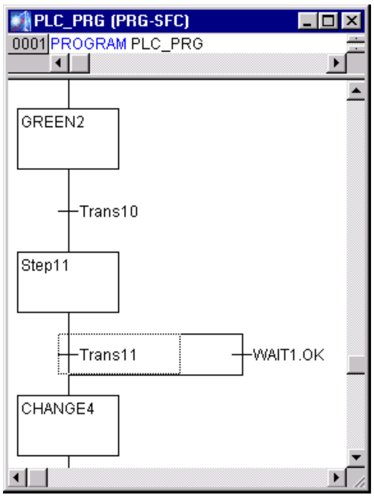
Program example

44. Select the transition after “CHANGE1“ and then **Insert→Step transition (after)** to insert a step transition.

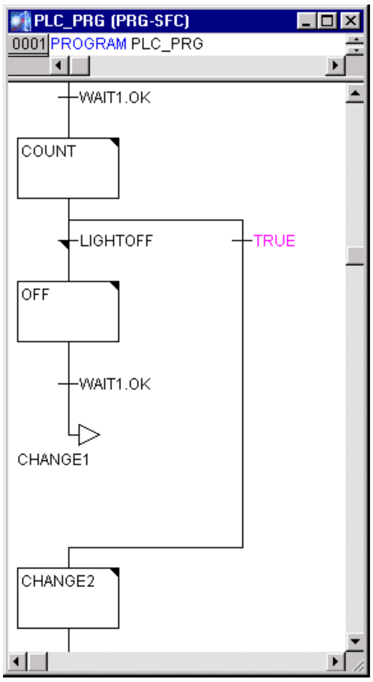


45. Select the newly new created transition and then **Insert→Alternative branch left** to insert an alternative branch to the left of it.



46. Select the left transition and then **Insert→Step transition (after)** to insert a step transition.
47. Select the newly new created transition and then **Insert→Jump** to insert a jump.

48.Name the newly inserted steps/transitions as shown below:



49.Define the following actions for the two new actions and the new transition condition:

Step	Actions	Information
COUNT	Action COUNT (IL) 0001 LD COUNTER 0002 ADD 1 0003 ST COUNTER	Counter increased by 1.
OFF	Action OFF (IL) 0001 CAL LIGHT1 (STATE:=5) 0002 CAL LIGHT2 (STATE:=5) 0003 LD 0 0004 ST COUNTER 0005 CAL WAIT1 (SETTIME:=t#10s)	Both traffic lights will be switched off for 10 seconds, and the counter will be reset to 0.

Transition	Actions	Information
LIGHTOFF	Transition LIGHTOFF (IL) 0001 LD COUNTER 0002 GT 7	Transition checks whether COUNTER is greater than a certain number (in this example: 7).

Our example switches the traffic light to night mode after seven cycles, then off for 10 seconds before the system switches to day mode and the process starts again.

Tip!

Select **File→Save as** to save the project under a new name.

- Use the dialog box *Save as*, input field **File name** to enter a name and then close the dialog box with **Save**.

3.3 Simulation

Now test the program.

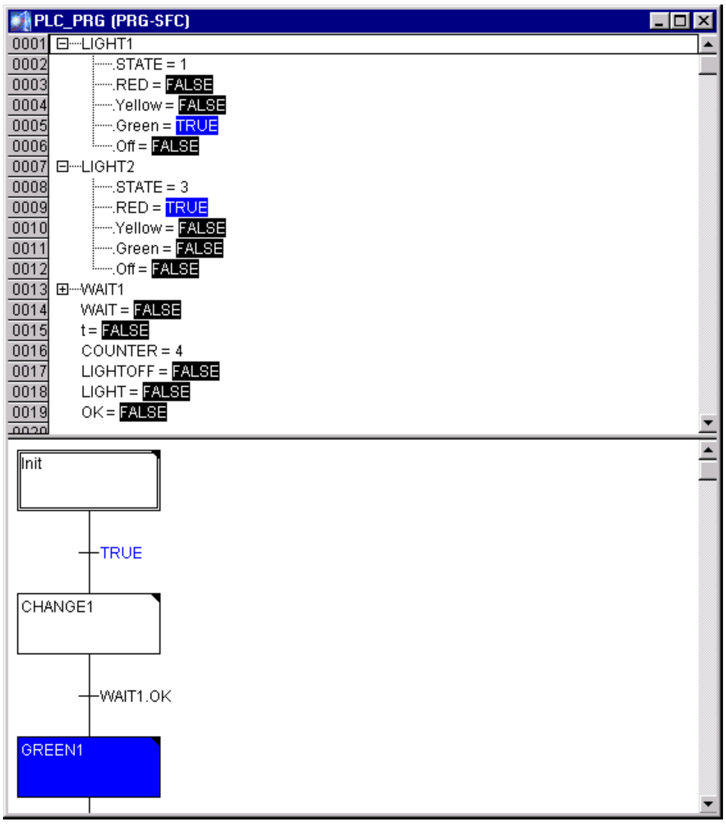
1. Select **Project→Compile all** to compile the program.
2. Select **Online→Simulation** to test the program in simulation mode.
3. Select **Online→Log in** to log into the control.
4. Select **Online→Start** to execute the program.

Since the simulation mode is activated, the program will be executed in the DDS instead of the control.

Monitoring

You can follow the sequence of the individual steps of your main program `PLC_PRG` in the editor window.

- The active step is displayed blue.
- Double-click the plus sign in the declaration editor to open the variable declaration and monitor the current individual variable values.



3.4 Visualization

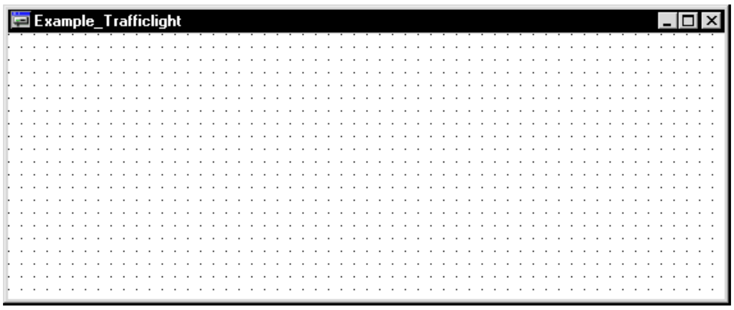
Now that the traffic light system has been programmed in the DDS and tested in simulation mode, we can use the DDS to visualize traffic light operation on screen.

3.4.1 Creating a new visualization

The DDS visualization feature is located on tab **Visualization** in the Object Organizer.

1. Select *Object Organizer* and then tab **Visualization**.
2. Select **Project→Object→Insert** to create a new visualization.
3. Use the dialog box *New visualization* to enter a new name for the visualization and confirm with **OK**.

The system will open a window to help create the new visualization:

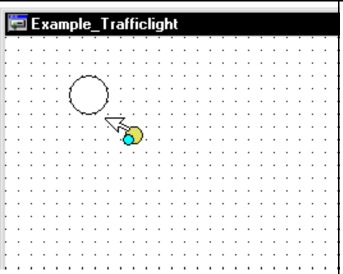
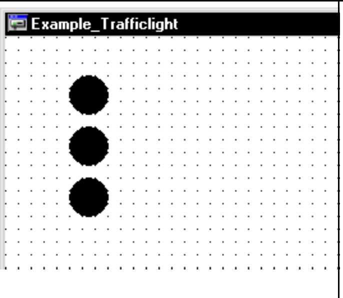


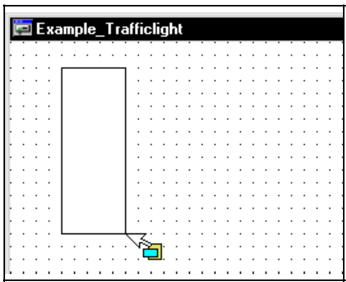
Tip!

Use the command **Extras→Settings** to open a dialog box to set the representation, frame and grid for the visualization.

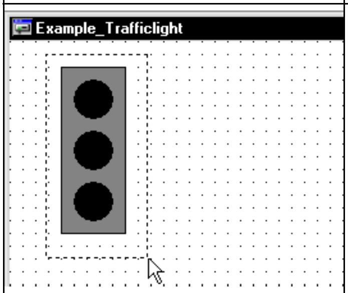
3.4.2 Inserting and configuring elements in the visualization

The elements circle (ellipse) and rectangle are rquired to represent the traffic lights.
The approach below is one of several:

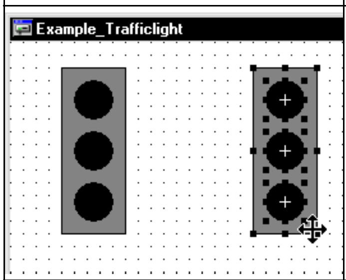
	1. Select **Insert→Ellipse** to draw a circle. 2. Double-click the circle to open the dialog box *Configure element* . 3. Use the category **Variables**, input field *Change colour* to enter the variable `PLC_PRG.LIGHT1.RED` . 4. Use the category **Colours** to select a dark shade for *Colour inside (fill colour)* . 5. Use the category **Colours** to select a red shade for *Signal colour inside (fill colour)* . 6. Copy the selected circle to the clipboard using **<Ctrl>+<C>**.
	7. Insert the copied circle twice into the drawing using **<Ctrl>+<V>** and position the inserted circles as shown on the left, keeping the left mouse key depressed. 8. Configure the inserted circles as follows with a double-click: – Middle circle: Category **Variables**, input field *Change colour*: `PLC_PRG.LIGHT1.YELLOW` Category **Colours**, *Colour inside (fill colour)*: select a dark shade Category **Colours**, *Signal colour inside (fill colour)*: select yellow shade – Bottom circle: Category **Variables**, input field *Change colour*: `PLC_PRG.LIGHT1.GREEN` Category **Colours**, *Colour inside (fill colour)*: select a dark shade Category **Colours**, *Signal colour inside (fill colour)*: select green shade



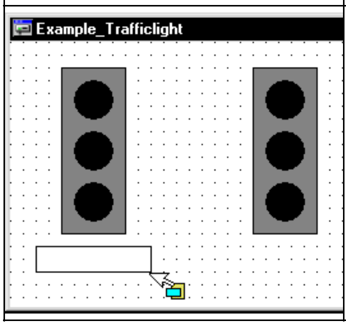
9. Select **Insert→Rectangle** to draw a rectangle over the three circles.
10. Double-click the rectangle to open the dialog box *Configure element* .
11. Use the category **Colours** to select a dark grey shade for *Colour inside (fill colour).*
12. Select **Extras→To the background** to put the rectangle behind the circles.



13. Use the mouse pointer to draw a frame around the elements to select all elements within the frame.
14. Copy the selected elements to the clipboard using **<Ctrl>+<C>**.

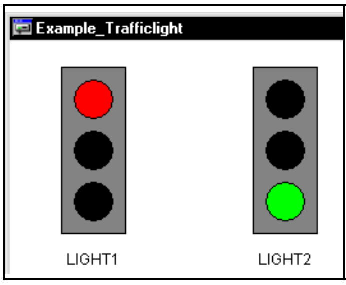


15. Insert the copied elements into the drawing using **<Ctrl>+<V>** and position the inserted elements as shown on the left, keeping the left mouse key depressed.
16. Configure the three circles of the traffic light on the right as follows with a double-click:
    - Upper circle:
      Category **Variables**, input field *Change colour*: `PLC_PRG.LIGHT2.RED`
    - Middle circle:
      Category **Variables**, input field *Change colour*: `PLC_PRG.LIGHT2.YELLOW`
    - Bottom circle:
      Category **Variables**, input field *Change colour*: `PLC_PRG.LIGHT2.GREEN`



17. Select **Insert→Rectangle** to draw a rectangle underneath each traffic light.
18. Configure the rectangles as follows with a double-click:
    - Use the category **Colours** to select **No frame colour**.
    - Use the category **Text** to enter a text for each traffic light (example: “LIGHT1” and “LIGHT2”).

3.4.3 Visualization in online mode



Restart the program, and the traffic lights will be ”on” in the visualization for the specified times, and correct functioning of the traffic control system can be very simply tested.

Tip!

For a detailed description of the visualization process refer chapter (📖 9-1)

4 Programming languages

4.1 The standard IEC 61131-3

The standard IEC 61131-3 is an international standard for PLC programming languages.

The programming languages implemented in the DDS are in conformity with the requirements of this standard.

According to this standard, a program consists of the following elements:

- Structures
- Organization units
- Global variables
- Local variables
- Configuration
- etc.

4.2 Instruction list (IL)

An instruction list (IL) consists of a sequence of instructions.

- Each instruction starts with a new line, contains an operator and - depending on the type of operation - one or several comma-separated operands.
- An instruction may be preceded by a jump label followed by a colon (;).
- Additional comments can be entered.
- Blank lines may be inserted between instructions.
- All commands are saved in an accumulator where intermediate results and the result of the last command are stored.

Example:

```
LD 17
ST lint (* comment *)
GE 5
JMPC next
LD idword
EQ istruct.sdword
STN test
next:
```

4.2.1 Operators and modifiers

The following operators and modifiers can be used in IL.

Modifiers

- **C**: conditional for **JMP**, **CAL**, **RET**:
  The instruction will only be carried out if the result of the preceding expression is **TRUE**.
- **N** for **JMPC**, **CALC**, **RETC**:
  The instruction will only be carried out if the result of the preceding expression is **FALSE**.
- **N** otherwise
  Negation of the operand (not of the accumulator).

The table lists some IL operators along with possible modifiers and their respective meaning:

Operator	Modifiers	Meaning	
LD	N (=”NOT”)	Load	Load instruction
ST	N	Store	Save the current result in the operand location
S		Set	Set Boolean operand to **TRUE** exactly if the current result is **TRUE**.
R		Reset	Set Boolean operand to **FALSE** exactly if the current result is **TRUE**.
AND	N,(		Bit-by-bit **AND**
OR	N,(		Bit-by-bit **OR**
XOR	N,(		Bit-by-bit exclusive **OR**
ADD	(		Addition
SUB	(		Subtraction
MUL	(		Multiplication
DIV	(		Division
GT	(	>	Greater than
GE	(	>=	Greater than or equal to
EQ	(	=	Equal to
NE	(	<>	Not equal to
LE	(	<=	Less than or equal to
LT	(	<	Less than
JMP/JMPC	N	Jump	Jump to label
CAL/CALC	N	Call	Call program or function block
RET/RETC	N	Return	Return from calling a function block
)			Evaluate operation that has been deferred

For a more comprehensive IEC operator list refer chapter 12.

Example

IL program using several modifiers

```
LD   TRUE  (* Load TRUE to the accumulator *)
ANDN BOOL1 (* Execute AND with the negated value
 of the variable BOOL1 *)
JMPC label  (* If the result was TRUE
 jump to the label "label" *)
LDN BOOL2  (* save the negated value of *)
ST ERG  (* BOOL2 in ERG *)

Label:
LD BOOL2  (* save the value of *)
ST ERG  (* BOOL2 in ERG *)
```

IL also allows the setting of parentheses after an operation. The value in parentheses is taken as operand.

Example 1

```
LD 2
MUL 2
ADD 3

ST Result
```

Example 2

```
LD 2
MUL (2
ADD 3
)
ST
```

- In example 1, the value of `Result` is 7.
- In example 2 with parentheses the value for `Result` is 10, because the operation **MUL** will only be evaluated on reaching ”)”; the operand for **MUL** is 5.

4.3 Structured text (ST)

Structured text consists of a series of instructions that can be executed as conditioned in very high-level languages (**IF..THEN..ELSE**) or in loops (**WHILE..DO**). An instruction is completed with a **semicolon;**.

Example:

```
IF value < 7 THEN
 WHILE value < 8 DO
value := value + 1;
 END_WHILE;
END_IF;
```

4.3.1 Expressions

An expression returns a value on evaluation and consists of operators and operands.

An operand can be

- a constant,
- a variable,
- a function call
- or another expression.

4.3.2 Evaluating expressions

Expressions are evaluated by processing operators following certain priorities. Operators with the highest priority are processed first followed by operators with the second highest priority and so on, until all operators are processed. Same-priority operators are processed from left to right.

The following table lists ST operators in the order of their priority.

Operation	**Symbol**	**Priority (ranking)**
Parentheses	(Expression)	Highest priority
Function call	Function name (parameter list)	
Exponentiation	EXPT	
Negation	-	
Complementation	NOT	
Multiplication Division	* /	
Modulo	MOD	
Addition Subtraction	+ -	
Compare Equal to Not equal to	<, >, <=, >= = <>	
Bool AND Bool XOR Bool OR	AND XOR OR	Lowest priority

4.3.3 Instructions (overview)

The following instructions are available in ST:

Instruction type	Example
Assignment by assignment operator	`A:=B;` `CV:=CV + 1;` `C:=SIN(X);`
Function block call use of the FB output	`CMD_TMR(IN:=%IX1.0.1, PT:=T#300ms);` `A:=CMD_TMR.Q`
RETURN	**RETURN**;
IF condition	`D:=B*B;` **IF** `D<0.0` **THEN** `C:=A;` **ELSIF** `D=0.0` **THEN** `C:=B;` **ELSE** `C:=D;` **END_IF**;
CASE s election	**CASE** `INT1` **OF** `1: BOOL1:=TRUE;` `2: BOOL2:=TRUE;` **ELSE** `BOOL1:=FALSE;` `BOOL2:=FALSE;` **END_CASE**;
FOR loop	`J:=101;` **FOR** `I:=1` **TO** `100 BY 2` **DO** `IF ARR[I]=70 THEN` `J:=I;` `EXIT;` `END_IF;` **END_FOR**;
WHILE loop	`J:=1;` **WHILE** `J<=100 AND ARR[J]<>70` **DO** `J:=J+2;` **END_WHILE**;
REPEAT loop	`J:=-1;` **REPEAT** `J:=J+2;` **UNTIL** `J= 101 OR ARR[J]=70` **END_REPEAT**;
EXIT	**EXIT**;
Dummy instruction	;

4.3.4 Assignment operator

The value of the expression on the right-hand side of an assignment is assigned to an operand (variable, address) on the left-hand side of an assignment by using the assignment operator `:=`.

Example:

```
Var1 := Var2 * 10;
```

After this line has been executed `Var1` is ten times the value of `Var2`.

4.3.5 Calling a function block in ST

A function block in ST is called by using the name of the function block instance followed by parentheses in which the parameters are assigned the required values.

Example

- A timer is called with assignments for parameters `IN` and `PT`:

  ```
  CMD_TMR(IN := %IX1.0.1, PT := T#300);
  ```

- The result variable `Q` is then assigned to variable `A`:

  ```
  A:=CMD_TMR.Q
  ```

- As in IL, the result variable is addressed using the function block name followed by a period and the variable name.

4.3.6 RETURN instruction

The **RETURN** instruction is used to complete the processing of the organization unit and to return to the calling organization unit, depending on a condition, for instance.

4.3.7 IF instruction

Use the **IF** instruction to check a condition. Instructions can be executed depending on this condition.

Syntax:

```
IF <Boolean_expression1> THEN
 <IF_instructions>
{ELSIF <Boolean_expression2> THEN
 <ELSIF_instructions1>
 ...
ELSIF <Boolean_expression n> THEN
 <ELSIF_instructions n-1>
ELSE
 <ELSE_instructions>}
END_IF;
```

- The part in curly brackets {} is optional.
- If `<Boolean_expression1> returns` **TRUE,** only `<IF_instructions>` will be executed.
- Otherwise the Boolean expressions starting with <Boolean_expression2> will be evaluated one after the other until one of the expressions returns **TRUE**. Then only the instructions after this Boolean expression and before the next **ELSE** or **ELSIF** will be evaluated.
- If none of the Boolean expressions is **TRUE**, only the `<ELSE_instructions>` will be evaluated.

Example:

```
IF temp < 17 THEN
 heating_on:=TRUE;
 ELSE
 heating_on:=FALSE;
END_IF;
```

In this example the heating is switched on only if the temperature falls below 17 degrees Centigrade, otherwise the heating will remain off.

4.3.8 CASE instruction

Use the **CASE** instruction to aggregate several conditional instructions with the same conditional variable.

Syntax:

```
CASE <Var1> OF
 <Value 1>:<instruction 1>
 <Value 2>:<instruction 2>
 ...
 <Value n>:<instruction n>
 ELSE
<ELSE instruction>
END_CASE;
```

A **CASE** instruction is processed as described below:

- If the variable in `<Var1>` is set to `<Value i>`, the instruction `<instruction i>` will be executed.
- If `<Var 1>` does not equal one of the specified values, the `<ELSE instruction>` will be executed.
- If the same instruction is to be executed for several variable values, these values can be comma-separated to indicate that they are linked to the same instruction.
- If the same instruction is to be executed for a value aggregate of the variable, the start and end values can be separated by two successive periods to indicate that they are linked to the same instruction.

Example:

```
CASE INT1 OF
 1,5:BOOL1:=TRUE;
 BOOL3:=FALSE;
 2:BOOL2:=FALSE;
 BOOL3:=TRUE;
 10..20:BOOL1:=TRUE;
 BOOL3:=TRUE;
 ELSE
 BOOL1:=NOT BOOL1;
 BOOL2:=BOOL1 OR BOOL2;
END_CASE;
```

4.3.9 FOR loop

Use the **FOR** loop to program repetitive procedures.

Syntax:

```
INT_Var :INT;

FOR <INT_Var>:=<INIT_VALUE> TO <END_VALUE> {BY <step size>} DO
 <instructions>
END_FOR;
```

- The part in curly brackets {} is optional.
- The `<instructions>` are executed as long as the counter`<INT_Var>` is not greater than the`<END_VALUE>`.
- A check is performed before the `<instructions>` are executed so that the `<instructions>` will never be executed if `<INIT_VALUE>` is greater than `<END_VALUE>`.
- Whenever the section `<instructions>` has been executed, `<INT_Var>` will be increased by `<step size>`.
- The step size can have any integer value. If no other step size is specified, step size 1 will be used. The loop must terminate because `<INT_Var>` will only become greater.
- If `<INIT_VALUE>` is greater than `<END_VALUE>` and `<step size>` is negative, the FOR loop is counted in opposite direction.
- If `<INIT_VALUE>` is less than `<END_VALUE>` and `<step size>` is negative, the FOR loop will not be executed.

Example:

```
FOR Counter:=1 TO 5 BY 1 DO
 Var1:=Var1*2;
END_FOR;
Res:=Var1;
```

Assuming that the variable `Var1` has been pre-assigned value 1, it will be 32 after the **FOR** loop.

Caution!

`<END_VALUE>` must not be the limit value of the counter `<INT_VAR>`.

If, for instance, the variable `Counter` is of type **SINT**, `<END_VALUE>` must not be 127 since otherwise the loop would be endless.

After completion of the FOR loop, Counter has a value 6.

4.3.10 WHILE loop

The **WHILE** loop can be used like a **FOR** loop, the only difference being that the cancel condition can be any Boolean expression.

Syntax:

```
WHILE <Boolean expression> DO
 <instructions>
END_WHILE;
```

- The `<instructions>` will be executed again and again until the `<Boolean_expression> returns` **TRUE**.
- If `<Boolean_expression>` is **FALSE** on first evaluation already, the `<instructions>` will never be executed.
- If `<Boolean_expression>` is never **FALSE** the `<instructions>` will be repeated endlessly, forcing a runtime error.

Note!

The programmer himself must ensure that endless loops do not occur by changing the condition in the instruction part of the loop, for instance change the counter settings. Otherwise the task with the endless loop would overflow.

Example:

```
WHILE Counter<>0 DO
 Var1:=Var1*2;
 Counter:=Counter-1;
END_WHILE
```

The **WHILE** and the **REPEAT** loops are more powerful in a way than the **FOR** loop since the number of loop cycles does not need to be known prior to loop execution.

In some cases, these two loop types will have to be sufficient.

If the number of loop cycles is known, however, a **FOR** loop should be preferred.

Task overflows can also occur in FOR loops. (📖 4-8)

4.3.11 REPEAT loop

The **REPEAT** loop differs from the **WHILE** loop in that the cancel condition will only be checked after the loop has been carried out. This means that the loop must be executed at least once no matter what the cancel condition is.

Syntax:

```
REPEAT
<instructions>
UNTIL <Boolean expression>
END_REPEAT;
```

- The <instructions> are executed until <Boolean expression> returns **TRUE**.
- If <Boolean expression> returns **TRUE** on first evaluation already, the <instructions> will be executed exactly once.
- If <Boolean_expression> is never **TRUE**, the <instructions> will be repeated endlessly, forcing a runtime error.

Example:

```
REPEAT
Var1:=Var1*2;
 Counter:=Counter-1;
 UNTIL
 Counter=0
END_REPEAT;
```

4.3.12 EXIT instruction

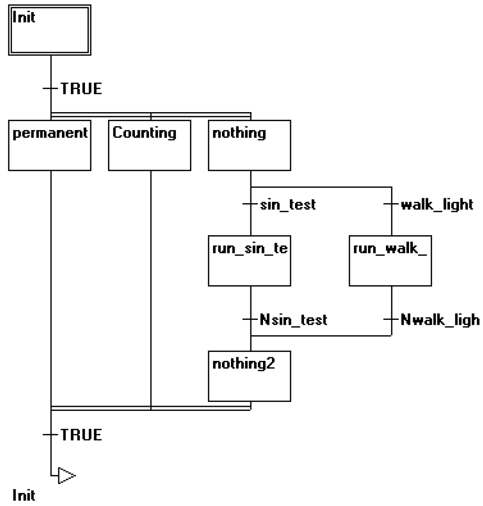
If the **EXIT** instruction is part of a **FOR**-, **WHILE** or **REPEAT** loop, the loop will be terminated irrespective of the cancel condition.

In nested loops, **EXIT** terminates the innermost loop.

4.4 Sequential Function Chart (SFC)

Sequential Function Chart is a graphically oriented language that enables the user to describe the chronological sequence of different actions within a program.

Example of a network in SFC



4.4.1 Step

An organization unit written in SFC consists of a sequence of steps that are interconnected through transitions.

There are two different step types:

- The simplified step consist of an action and a flag to indicate whether the step is active or not. A small triangle appears in the top right-hand corner of the step to indicate that the action for a step has been implemented.
- An IEC step consists of a flag and one or more assigned actions or Boolean variables. The associated actions appear to the right of the step.

4.4.2 Action

An action may contain a sequence of instructions in IL, CFC or ST, a number of networks in FBD or LD or another sequence structure (SFC).

- Simplified steps always have an action linked to the step.
- Actions can be edited by double-clicking the step linked to the action or selecting the step before executing menu command **Extras→Zoom action/transition**. Furthermore, the configuration allows one entry and / or one exit action per step.
- In the *Object Organizer*, actions of IEC steps are grouped directly underneath their SFC organization unit and can be loaded into the editor with a double-click or pressing the **<Enter>** key. New actions can be generated with **Project→Add action**.

4.4.3 Entry and exit action

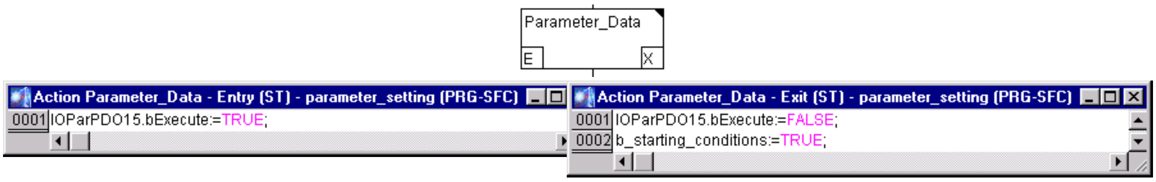
In addition to the step action, a step may be added an entry action and an exit action.

- An entry action is executed once-only immediately after the step has been activated.
- An exit action is executed once-only before the step is deactivated.
- Entry and exit actions can be implemented in any language.

A step with entry action is identified with an 'E' in the bottom left-hand corner, the exit action with an 'X' in the bottom right-hand corner.

- Double-click the respective corner in the step to edit an entry or exit action.

Example of a step with entry and exit actions:



Note!

Any exit action contained in the active step will be executed during the next cycle only, provided the subsequent transition is TRUE.

4.4.4 Transition/transition condition

There are so-called transitions between the steps.

A transition condition must have a value `TRUE` or `FALSE` and can therefore consist of

- a Boolean variable
- a de-referenced address to Boolean variable (*poTo_bTest*)
- a Boolean constant (`TRUE`)
- a sequence of instructions with a Boolean result in ST syntax (e.g. `(i<=100) AND b`)
- a sequence of instructions programmed in any language

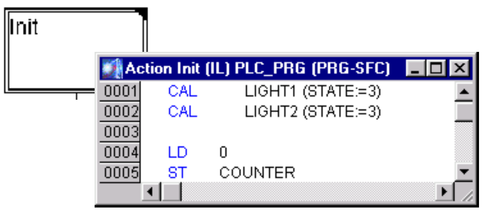
A transition must not contain any programs, function blocks or assignments.

Tip!

The next step can be reached both via transitions and the single step mode. (SFCtip and SFCtipmode)

4.4.5 Active step

The initial SFC editor call always executes the action pertaining to the initial step.



- A step whose action is being executed is referred to as the active step.
- In online mode, active steps are displayed in blue.

In a control cycle, all actions belonging to active steps are being executed. The subsequent transition condition is checked once an active step has been executed. If the transition condition is met (**TRUE**), the subsequent step will be executed during the next control cycle.

Step flag

Each step has a flag to save the step status.

Note!

A step flag bears the step's name.

A step and a Boolean variable must not bear the same name as logical errors may otherwise occur.

- The flag does not need to be explicitly declared.
- The step flag (active or inactive step status) is represented by the logical value of a Boolean variable `<StepName>`.
- This Boolean variable has a value **TRUE** if the associated step is active, and **FALSE** if it is not. This variable is implicitly declared and can be used in any action and transition of the SFC organization unit.

Time flag

The active time of a step can be interrogated via flag **_time** `<StepName>`.

- The flag does not need to be explicitly declared.
- Interrogation works only if a minimum time was set in the step attributes for the step to be interrogated, for example `t#0ms`.

4.4.6 IEC step

SFC also offers standard-compliant IEC steps in addition to the simplified steps.

Include the SFC library iecsfc.lib into your project to use IEC steps.

An IEC step can be assigned any number of actions.

- Unlike simplified steps, IEC actions are not firmly assigned to a step as an entry or exit action, but are available separately from the steps and can be applied more than once within their organization unit. For this purpose, IEC actions must be linked with the desired steps with the help of command **Extras→Associate action**.

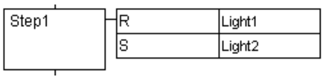
Not only actions but also Boolean variables can be assigned to steps.

- So-called qualifiers control activation and deactivation of actions and Boolean variables, also permitting time delays.
- Concurrences may occur since an action may still be active even if the next step may already be processed, via qualifier **S** (Set), for example.

Associated Boolean variables are set or reset on each SFC organization unit call, i. e. it is reassigned either the value **TRUE** or **FALSE** each time.

The actions associated with an IEC step are displayed in a split box to the right of the step. The left-hand field contains the qualifier (if necessary with time constants), the right-hand field the name of the action or the Boolean variable.

Example of a two-action IEC step:



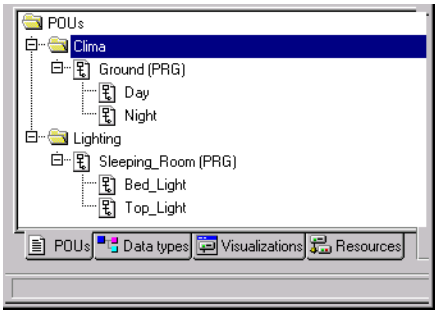
- For easier monitoring of the processes, all active actions, like active steps, are displayed in blue in online mode. Which actions are active, is checked after every cycle.
- Whether a newly inserted step is an IEC step is dependent on whether menu command **Extras→Use IEC steps** has been selected.

Note!

Note restriction on the use of time qualifiers for actions used more than once within the same cycle.

Following a call, the deactivated actions are processed first before all active actions, both in alphabetical sequence.

In the *Object Organizer*, the actions are attached directly under the associated SFC organization unit:



- New actions can be generated with **Project→Add action**.

4.4.7 Qualifiers

The following qualifiers are available to associate actions to IEC steps:

N	Non-stored	The action is active as long as the step is active.
R	overriding Reset	The action is deactivated.
S	Set (Stored)	The action is activated and remains active until reset.
L	time Limited	The action is active for a certain period of time but no longer than the step is active.
D	time Delayed	The action will become active after a certain period of time, as long as the step is still active, and then as long as the step remains active.
P	Pulse	The action is executed exactly once-only when the step becomes active.
SD	Stored and time Delayed	The action is activated after a certain period of time and remains active until reset.
DS	Delayed and Stored	The action is activated after a certain period of time as long as the step is still active, and remains active until reset.
SL	Stored and time Limited	The action is active for a certain period of time.

- The qualifiers `L`, `D`, `SD`, `DS` and `SL` require a time specification in `TIME` constant format, e.g. `L T#5s`.

Note!

When an action is deactivated, it will be executed once again. This means that every action is executed at least twice (even actions with qualifier `P`).

If the same action is applied in two directly successive steps with time-affecting qualifiers, the time qualifier will not be effective on second use. To avoid this behaviour, insert an intermediate step to allow re-initialization of the action status in the additional cycle that must then be run.

4.4.8 Implicit SFC variables

SFC provides implicitly declared variables for use.

- The step flag (active or inactive step status) is called <StepName>`.x` for IEC steps.
- This Boolean variable has a value `TRUE` if the associated step is active, and `FALSE` if it is not. This variable is implicitly declared and can be used in any action and transition of the SFC organization unit.
- Whether an IEC action is active or not can be interrogated with the help of variable <ActionName>`.x`. During the IEC action deactivation run, this variable already holds a value `FALSE`.
- With IEC steps, the implicit variable <StepName>`.t` can be used to interrogate the active time of a step.
  Interrogation works only if a minimum time was set in the step attributes for the step to be interrogated, for example `t#0ms`.

4.4.9 SFC flags

SFC flags are for step control and must be globally or locally declared.

Flag variables and their properties

SFCEnableLimit

This specific variable is a `BOOL`-type variable. If `TRUE`, the process registers step timeouts in `SFCError` and otherwise ignores them. This application may be useful for commissioning or manual operation, for example.

SFCInit

If this variable is `TRUE`, the SFC and the other flags are reset to the init step (initialization). As long as the variable is `TRUE`, the init step remains set without being executed. If `SFCInit` is reset to `FALSE`, the organization unit will be processed further.

SFCReset

This `BOOL`-type variable behaves similarly to `SFCInit`. Although the init step is processed further following initialization. This behaviour may be used to set the `SFCReset` flag in the init step immediately back to `FALSE`.

Note!

`SFCInit` and `SFCReset` cannot be used simultaneously in one organization unit. `SFCInit` will always have priority.

Example of a declaration

```
PROGRAM flags
VAR
 SFCEnableLinit:BOOL;
 SFCError:BOOL;
 SFCErrorStep:STRING;
 SFCReset AT %IX1.0.2: BOOL;
 SFCInit AT %IX1.0.3:BOOL;
END_VAR
```

SFCQuitError

Processing of the SFC diagram will be suspended for as long as this Boolean variable remains **TRUE**. Timeouts in variables **SFCError** will be reset. All previous times in the active steps will be reset when the variable is reset to **FALSE**.

SFCPause

Processing of the SFC diagram will be suspended for as long as this Boolean variable remains **TRUE**.

SFCError

This Boolean variable becomes **TRUE** if a timeout occurred in an SFC diagram. If variable **SFCError** is not reset again, and the first timeout is then followed by a second one in the program, the second one will not be registered.

SFCTrans

This Boolean variable becomes **TRUE** when a transition switches.

SFCErrorStep

This variable is a **STRING**-type variable that, if **SFCError** registers a timeout, stores the name of the step that causes the timeout.

SFCErrorPOU

This **STRING**-type variable, after a timeout, contains the name of the organization unit in which the timeout occurred.

SFCCurrentStep

This variable is a **STRING**-type variable that saves the name of the active step independently of the watchdog function. In parallel branching, the step is saved in the branch at the extreme right.

SFCTip, SFCTipMode

These **BOOL**-type variables permit the SFC tip mode. If that is activated via **SFCTipMode** = **TRUE**, the next step can be reached only if **SFCTip** is set to **TRUE**. As long as **SFCTipMode** is set to **TRUE**, the transitions may also be used for switching.

SFCErrorAnalyzation

This variable is a **STRING**-type variable. If the SFC flag **SFCError** registers a timeout, **SFCErrorAnalyzation** outputs the responsible variables or transition expressions.
This function requires the library Analyzation.lib to be integrated into the DDS project.

Note!

On some target systems, the length of the output of variables or transition expressions can be limited.

In some cases the string routines can only process 20 characters.

4.4.10 Alternative branch

Two or more branches in SFC may be defined as alternative branches.

- Every alternative branch must start and end with a transition.
- Alternative branches may include parallel branches and further alternative branches.
- An alternative branch starts with a horizontal line (alternative start) and ends with a horizontal line (alternative end) or a jump.
- If the step before the alternative start line is active, the first transition of every alternative branch will be evaluated from left to right. The first transition from the left, whose transition condition is `TRUE`, is opened and the subsequent steps are activated.

4.4.11 Parallel branch

Two or more branches in SFC may be defined as parallel branches.

- Every parallel branch must start and end with a step.
- Parallel branches may include alternative branches or further parallel branches.
- A parallel branch starts with a double line (parallel start) and ends with a double line (parallel end) or a jump and can be assigned a jump label.
- If the step before the parallel start line is active, and the transition condition after this step is `TRUE`, the first steps of all parallel branches will become active. These branches will then all be processed in parallel.
- The step after the parallel end line will become active if all preceding steps are active and the transition condition before this step is `TRUE`.

4.4.12 Jump

A jump is a connection to the step whose name appears underneath the jump icon.

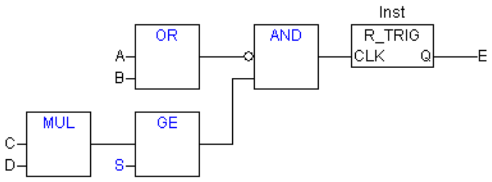
Jumps are necessary because upward or intersecting connections are not allowed.

4.5 Function block diagram (FBD)

The function block diagram is a graphically oriented programming language.

It uses a list of networks, each of which contains a structure that represents a logical or arithmetic expression, a function block call, a jump, or a Return instruction each.

Example of a network in FBD:



4.6 The Continuous Function Chart editor (CFC)

The Continuous Function Chart editor (CFC) operates with freely placeable elements that allow feedbacks, for example.

Example of a network in the Continuous Function Chart editor.

4.7 Ladder diagram (LD)

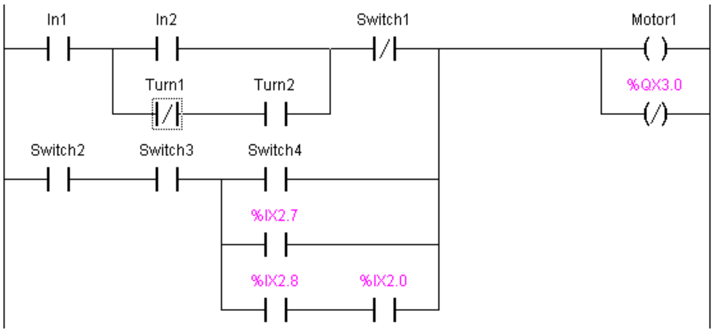
The Ladder Diagram is a graphically oriented programming language which is similar to the principle of an electrical circuit.

LD is used for the design of logic circuits and also allows the creation of networks as in FBD. LD is therefore perfectly suited to control calls for other organization units.

LD consist of several networks.

- A network is limited on the left and on the right by a vertical power cable. In-between is a circuit diagram consisting of contacts, coils and connection lines that transmit the status "ON" or "OFF" (**TRUE** or **FALSE**) from left to right.

Example of a network in LD:



4.7.1 Contact

Every network in LD consists of a network of contacts on the left-hand side, which transmit the status "ON" or "OFF" from left to right (variable value **TRUE** or **FALSE**).

If a Boolean variable of a contact has the value **TRUE**, the status "ON" is transmitted via the connection line from left to right. Otherwise, the right-hand connection is set to "OFF".

Parallel or series connection

- Contacts can be connected in parallel. In that case one of the parallel branches must transmit the value "ON" to ensure that the entire parallel branch transfers the value "ON".
- Contacts can be connected in series. In that case, all contacts must transmit the status "ON" to ensure that the last contact transmits "ON".

Negation

A contact can also be negated. It is then identified with a slash in the contact symbol. The contact then transmits the input status if its status is "OFF" (**FALSE**).

4.7.2 Coil

Any number of so-called coils (represented by brackets) are listed on the right-hand side of a network in LD.

- A coil transmits the connection value from left to right and copies it into an associated Boolean variable.
- The input line can be set to "ON" or "OFF" (depending on the Boolean values **TRUE** or **FALSE**).
- Coils can only be connected in parallel.

Negation

Coils can also be negated (shown by a slash in the coil symbol). In that case, the coil copies the negated value to the associated Boolean variable.

4.7.3 Set/Reset coil

A coil can also be defined as set or reset coil.

- A variable of a set coil becomes **TRUE** if the network result is **TRUE**.
- A variable of a reset coil becomes **FALSE** if the network result is **FALSE**.
- If the conditions are not fulfilled, the variable does not change.

A set coil (”S” in the coil symbol) can assume ”ON” status, but can then no longer be reset to ”OFF”.

A Reset coil (”R” in the coil symbol) can assume ”OFF” status, but can then no longer be reset to ”ON”.

4.7.4 Function blocks in LD

In addition to contacts and coils, LD allows the input of function blocks and programs.

In the network, function blocks and programs must have an input and output with Boolean values and can be used at the same locations as contacts, i.e. on the left-hand side of the LD network.

4.7.5 LD as FBD

Use global variables or direct calls if the result of a circuit in LD is to be used to control other organization units.

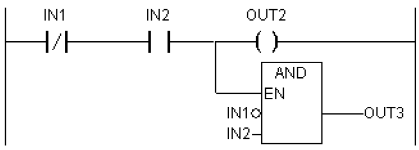
Global variable

The result of a circuit can be saved with the help of the coils in a global variable that is then further used otherwise.

Direct call

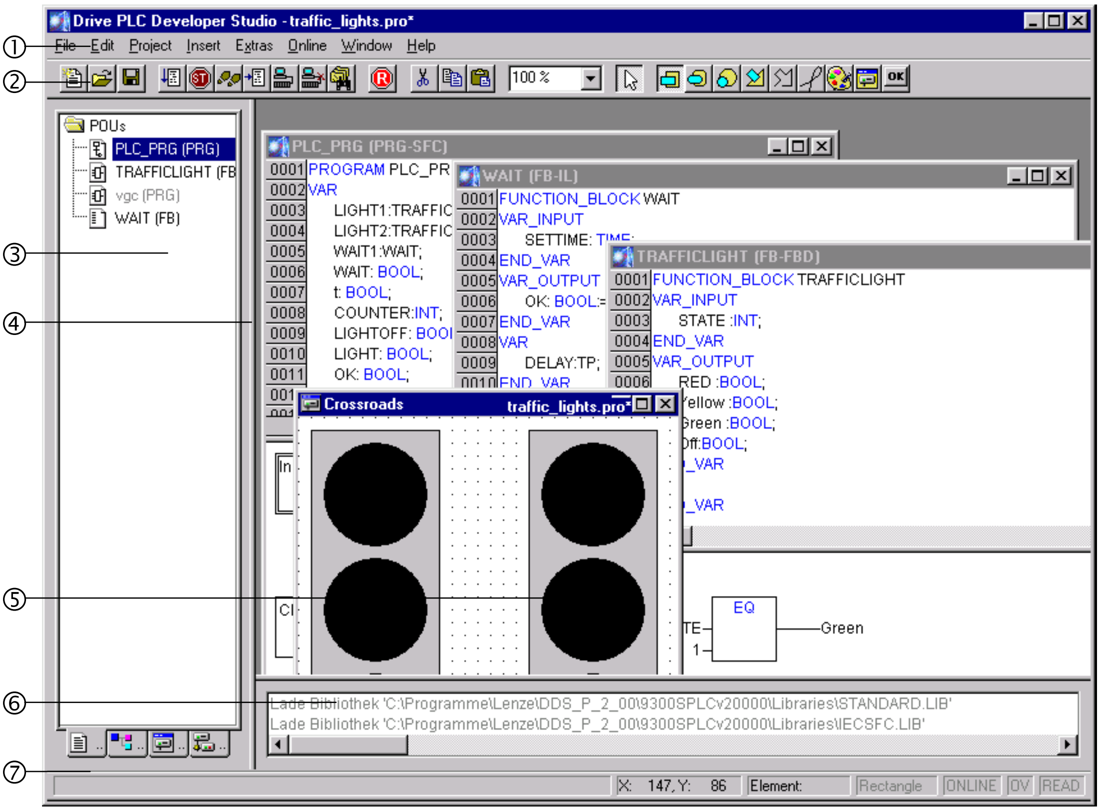
The call can be directly installed into your LD network. For this purpose, insert an EN organization unit (”EN” stands for ”Enable”).

- EN organization units are normal operators, functions, programs or function blocks that have an additional input labelled EN. This input is a **BOOL**-type input.
- An EN organization unit will only be evaluated if its EN input is **TRUE**.
- An EN organization unit is switched in parallel to the coils, with the EN input being linked to the connection line between the contacts and the coils. If the status ”ON” is transmitted via this line, the organization unit will be evaluated normally.
- Based on such an EN organization unit, networks can be generated as in FBD.



5 Desktop

5.1 User interface



The DDS user interface consists of the following elements:

① Menu bar
② Tool bar (optional)
③ *Object Organizer*
④ Vertical screen divider between the *Object Organizer* and the DDS desktop.
⑤ Desktop with the editor windows.
⑥ Message window (optional)
⑦ Status bar (optional)

5.1.1 Menu bar

The menu bar is located at the top end of the main window and contains all DDS menu commands.

5.1.2 Tool bar

The tool bar provides for quick access to frequently used menu commands.

- Click on an icon to execute the underlying command.

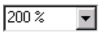
Tip!

Positioning the mouse pointer briefly over a tool bar icon will display a tooltip with the icon name.

Use the FIND function in the Online Help to display more detailed information on the associated icon and its functionality.

- The selection of available functions is dependent on the active window.
- Tool bar display is optional.
  Project→Options category *Desktop*

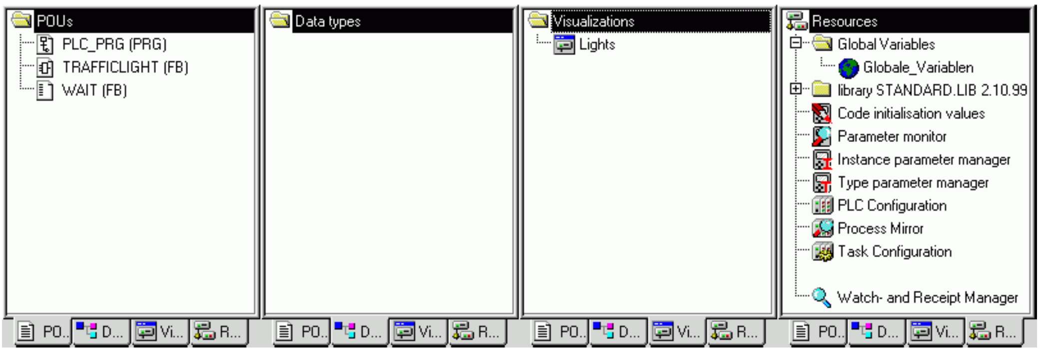
5.1.2.1 Zoom



This zoom function in the tool bar allows zooming within all graphic editors and the visualization. Zoom is effective in the active window only.

The organization units of editors and visualization can be edited more efficiently.

5.1.3 Object Organizer



The *Object Organizer* is located at the left-hand side of the DDS main window and allows fast access to the four object types:

- Organization units
- Data types
- Visualizations
- Resources

Click the associated tab in the *Object Organizer* to change between the object types, or use the left or right arrow key.

5.1.4 Vertical screen divider

The screen divider is the boundary between two non-overlapping windows.

The DDS offers screen dividers between

- the *Object Organizer* and the desktop of the main window
- the interface (declaration part) and the implementation (instruction part) of organization units
- the desktop and the message window.

Position the mouse pointer over the screen divider to move it. For this purpose, keep the left mouse key depressed and move the mouse.

Tip!

Note that the screen divider will always remain at its absolute position even if the window size is changed. Enlarge the window if the screen divider seems to have disappeared.

5.1.5 Desktop

The desktop is on the right-hand side of the DDS main window. All object editors and the Library Manager are opened in this pane. The window title bar displays the associated object name. Organization units are identified with an abbreviated organization unit type and the applied programming language.

Tip!

Menu command **Window** in the main menu lists all window management commands.

5.1.6 Message window

The message window appears below the desktop in the main window, separated by a horizontal screen divider.

It contains all messages from the last compile, check or compare. Search results and cross references can also be output here.

- Double-click a message in the message window or press **<Enter>** to open the editor with the associated object. The relevant line of the object will be highlighted.
  Use the commands **Edit→Next fault** and **Edit→Previous fault** to jump from one error message to the next.
- The message window can be shown or hidden by pressing **<Shift>+<ESC>**.

5.1.7 Status bar

The status bar at the bottom of the DDS main window displays information about the current project and menu commands.

- If a status applies, the associated expression appears in black at the right-hand end of the status bar, otherwise it is greyed out.
- Status bar display is optional.
  Project→Options category *Desktop*

Online mode

In online mode, the word **Online** is displayed in black; in offline mode, it is greyed out.

The status bar shows the following statuses in online mode.

- **SIM**: DDS is in simulation mode
- **RUNNING**: the program is being processed
- **BP**: a breakpoint is set

Other status bar displays

- Text editors display the line and column number of the current cursor position. The letters **OVR** appear in the status bar in overtype mode.
- If the mouse pointer is in a visualization, the current X and Y position of the cursor will be given in pixels relative to the top left-hand corner of the image.
- If the mouse pointer is positioned over an element, or if an element is being edited, the number of the element will be displayed.
- If an element has been selected for insertion, this element will also be displayed (e.g. rectangle).
- If a menu command has been selected but not confirmed, a short description will be given in the status bar.
- The status bar displays the word **READ** if a project is opened with read access only.

5.1.8 Shortcut menu

Keyboard: **<Umschalt>+<F10>**

Use the right mouse key to display a shortcut menu.

- The shortcut menu contains the commands most frequently used for a selected object or the active editor.
- The selection of available commands is dependent on the active window.

5.2 Arrange windows

The menu **Window** lists all window management commands.

These are commands for automatic window arrangement, opening the Library Manager and the log and to change between active windows.

The menu **Window** also lists all open windows at the bottom in the sequence they were activated.

- Click an entry to change to the associated window. The active window is identified with a tick (✓) in front of the menu entry.

5.2.1 Commands in the "Window" menu

5.2.1.1 Tile horizontally

Icon:	-	Menu:	**Window→Tile horizontally**	Keyboard:	-

Use this command to tile all windows on the desktop horizontally so that they will not overlap but fill the whole desktop.

5.2.1.2 Tile vertically

Icon:	-	Menu:	**Window→Tile vertically**	Keyboard:	-

Use this command to tile all windows on the desktop vertically so that they will not overlap but fill the whole desktop.

5.2.1.3 Cascade

Icon:	-	Menu:	**Window→Cascade**	Keyboard:	-

Use this command to cascade all windows on the desktop.

5.2.1.4 Arrange icons

Icon:	-	Menu:	**Window→Arrange icons**	Keyboard:	-

Use this command to arrange all windows minimized on the desktop in a row at the bottom of the desktop.

5.2.1.5 Close all

Icon:	-	Menu:	**Window→Close all**	Keyboard:	-

Use this command to close all windows open on the desktop.

5.2.1.6 Messages

Icon:	-	Menu:	**Window→Messages**	Keyboard:	**<Umschalt>+<Esc>**

Use this command to open or close the message window displaying the messages from the last compile, check or compare.

- If the message window is open, a tick (✓) appears in front of the command in the menu.

5.2.1.7 Library Manager

Icon:	-	Menu:	**Window→Library Manager**	Keyboard:	-

Use this command to open the dialog box *Library Manager* (📖 8-41)

5.2.1.8 log

Icon:	-	Menu:	**Window→log**	Keyboard:	-

Use this command to open the log window. The menu command **log** is available for the open log window. (📖 6-42)

5.3 Basic settings

5.3.1 DDS options

Use the menu command **Project→Options** in the main menu to configure the display of your main window. There are other setting options for DDS customization.

Unless otherwise defined, the settings made here will be stored in the DDS ini file and restored on next start.

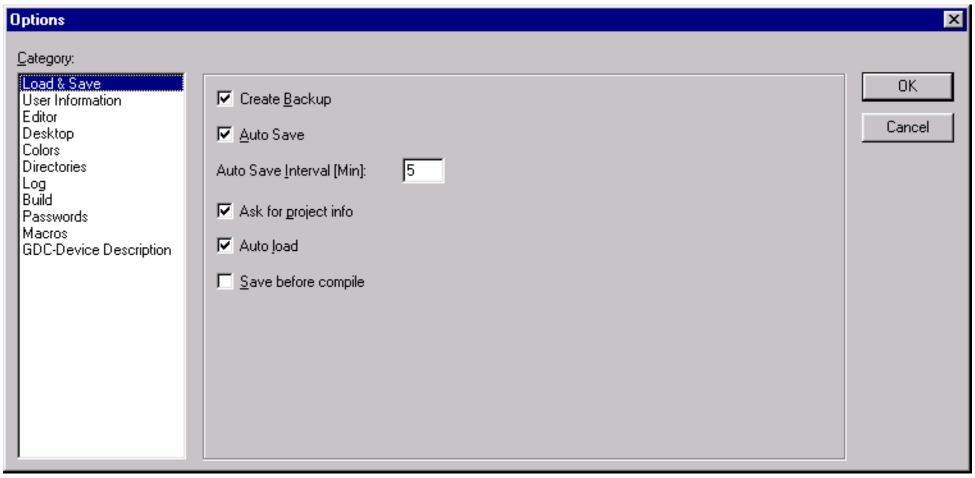
5.3.1.1 Options

Icon: -	Menu: **Project→Options...**	Keyboard: -

Use this command to open the dialog box *Options*.

The options are divided into several categories. Select the required category from the left-hand side of the field *Category* with a mouse click, or use the arrow keys to do so, and set the required options on the right-hand side.

Options→Load & save



If an option is active, a tick appears in front of the option. (✓)

Creating a backup

If check box **Create backup** is activated, the DDS saves the old file to a backup file with the extension ".bak" on each save to allow for the version before the last save to be restored.

Autosave

If check box **Autosave** is activated, your project, while being edited, will be constantly saved to a temporary file with an ".asd" extension in accordance with the specified time interval (save interval). This file will be deleted when the program completes normally.

Should the DDS terminate "abnormally" for some reason (mains failure, for example), the file will not be deleted and the system will display a message on project re-launch to advise that a backup file has been created. It is now up to the user to decide which file to open (original or backup file).

Autosave interval (min)

Enter a time interval in minutes for temporary backup.

Ask for project information

If check box **Ask for project information** is activated, the project information will be called automatically when a new project is saved or an existing project is stored under a new name.

Project information can be viewed and edited using the menu command **Project→Project information**.

Autoload

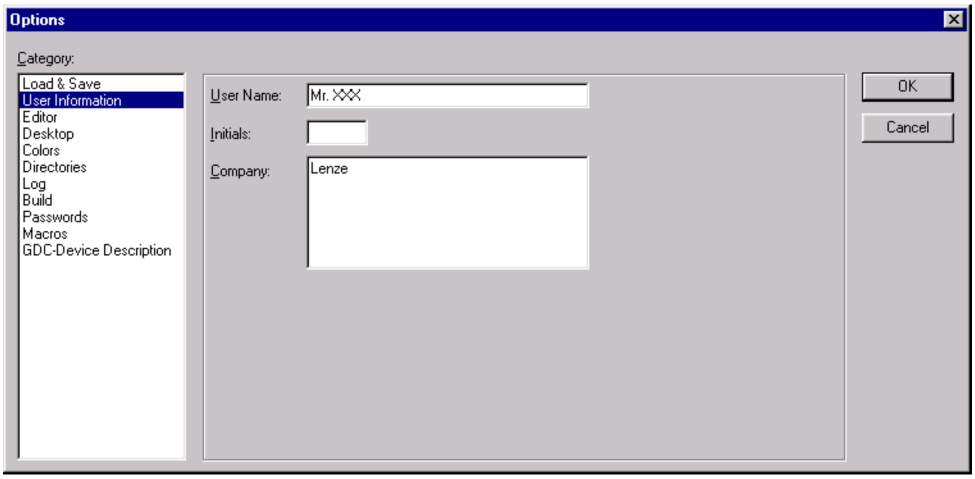
If the option **Autoload** is activated, the project opened last will be loaded automatically next time the DDS is started.

A project can also be loaded on DDS start by specifying the project name in the command line.

Save before compile

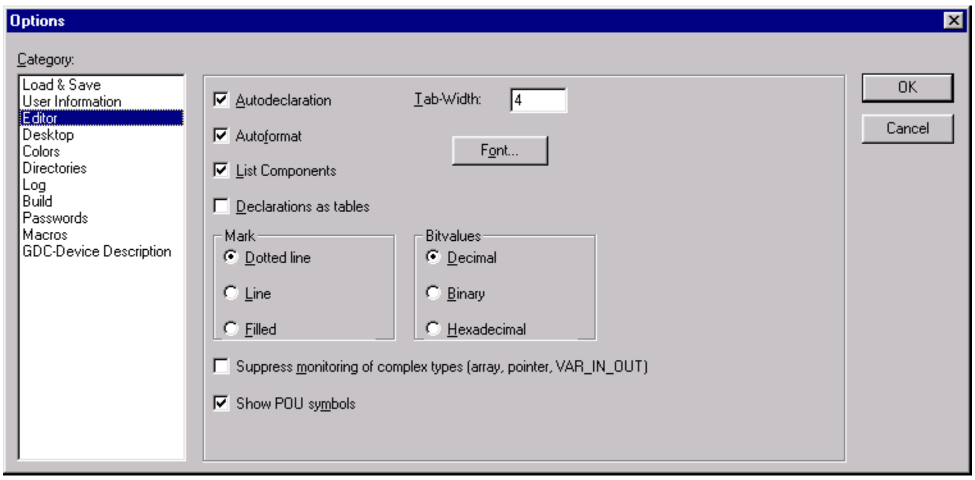
The project is saved prior to each compile.

Options→User information



Every entry can be changed and will be saved together with the project.

Options →Editor



If an option is active, a tick appears in front of the option. (✓)

Auto declaration

If the option **Auto declaration** is activated, a dialog box will appear in all editors when entering a variable that has not been declared yet. This dialog box is called *Variable declaration*.

Autoformat

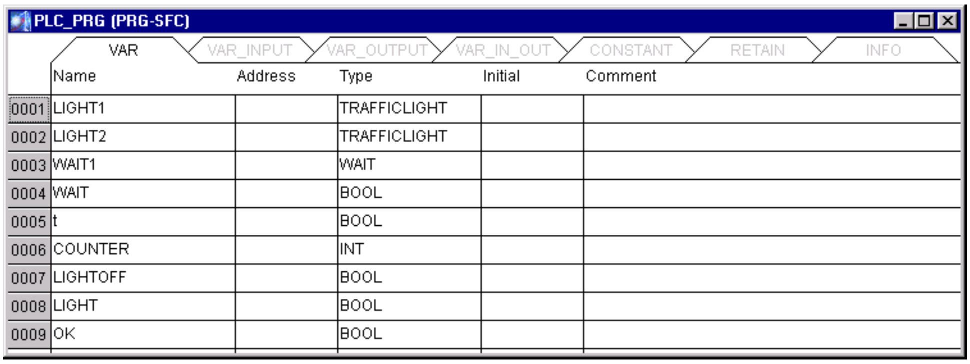
If the option **Autoformat** is activated, the DDS carries out automatic formatting in the instruction list editor and the declaration editor.

After a line has been exited, the following will be formatted:

- Lowercase operators will be displayed in uppercase.
- Tabs will be inserted for uniform column arrangement.

Declarations as tables

If the option **Declarations as tables** is activated, variables can be edited as table instead of using the declaration editor.



	Name	Address	Type	Initial	Comment
0001	LIGHT1		TRAFFICLIGHT		
0002	LIGHT2		TRAFFICLIGHT		
0003	WAIT1		WAIT		
0004	WAIT		BOOL		
0005	t		BOOL		
0006	COUNTER		INT		
0007	LIGHTOFF		BOOL		
0008	LIGHT		BOOL		
0009	OK		BOOL		

- This table is arranged as a card index box with tab cards for input, output, local and input/output variables.
- Fields for name, address, type, initial value and comment are available for each variable.

Tab width

Use the field **Tab width** to specify the tabulator width for the editors.

- The default setting is four characters, with the character width being dependent on the selected font.

Font

Click **Font** to open the dialog box *Font* and select the font for the editors.

- The font size is a basic unit for all drawing operations. A larger font size therefore does not only result in a larger image but also a larger printout for each DDS editor.

Mark

Use the group box **Mark** to choose from three different marking formats for the graphic editors.

- **Dotted line**: The mark is a dotted rectangle.
- **Line**:The mark is a rectangle consisting of a continuous line.
- **Filled**: The mark is a filled rectangle (inverse).

A dot identifies the active selection.

Bit values

Use the group box **Bit values** to choose between three different representation formats for binary data (types `BYTE`, `WORD`, `DWORD`) for monitoring:

- **Decimal**
- **Hexadecimal**
- **Binary**

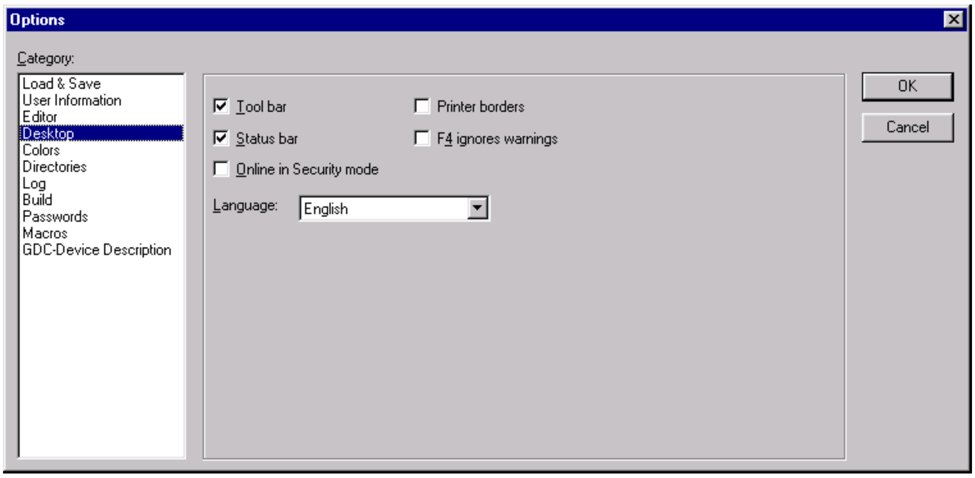
A dot identifies the active selection.

Monitoring of complex types

Show POU symbols

If chec box **Show POU symbols** is selected, Lenze organization unit signal propagation charts are shown as bitmaps.

Options →Desktop



If an option is active, a tick appears in front of the option. (✓)

Tool bar

If the option **Tool bar** is activated, the tool bar will be displayed below the menu bar for faster access to menu commands.

Status bar

If the option **Status bar** is activated, the status bar will be displayed at the bottom edge of the DDS main window.

Online in security mode

If the option **Online in security mode** is activated, online mode displays a dialog box for the commands **Start**, **Stop**, **Reset**, **Breakpoint on**, **Single cycle** and **Write values** offering an additional security prompt as to whether the command is indeed to be executed. This option is saved together with the project.

Language

DDS dialog and menu languages are German and English.

Note!

Languages can be selected under Windows NT and Windows 2000 only.

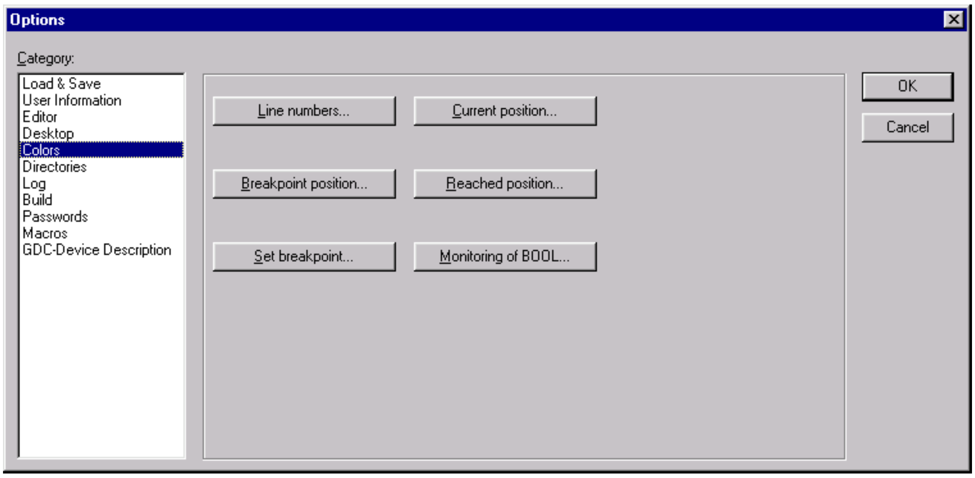
Printer borders

In every editor window, the printer borders are outlined by red dashed lines. The printer borders are dependent on printer properties and the size of the content area of the set template **File→Documentation setup**.

F4 ignores warnings

Pressing **F4** after the compile will return the focus only to those lines with error messages in the message window, ignoring the warning outputs.

Options →Colours



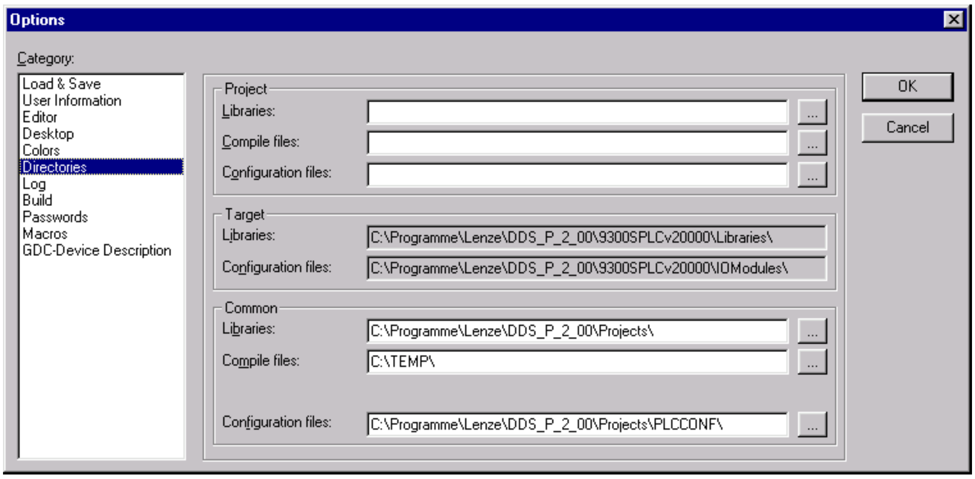
DDS colour settings can be changed for the following elements:

- **Line numbers** (light grey*)
- **Breakpoint position** (dark grey*)
- **Set breakpoint** (light blue*)
- **Current position** (red*)
- **Reached position** (green*)
- **Monitoring of BOOL** (blue*)

Click one of the buttons to open the dialog box *Colours* and select the required colour for the element.

*DDS default

Options→Directories



Project

The DDS is looking for libraries and configuration files in directories entered in a project. It is also possible to enter directories that are to be used to store compile files.

Click (...) behind an input field to open a dialog box for the selection of directories within your directory structure (Browse). For library and configuration files, the system allows the input of several paths each, separated by a semicolon ";". The information is saved together with the project.

Common

This is where those directories can be entered that the DDS will search for libraries and configuration files. It is also possible to enter directories that are to be used to store compile files.

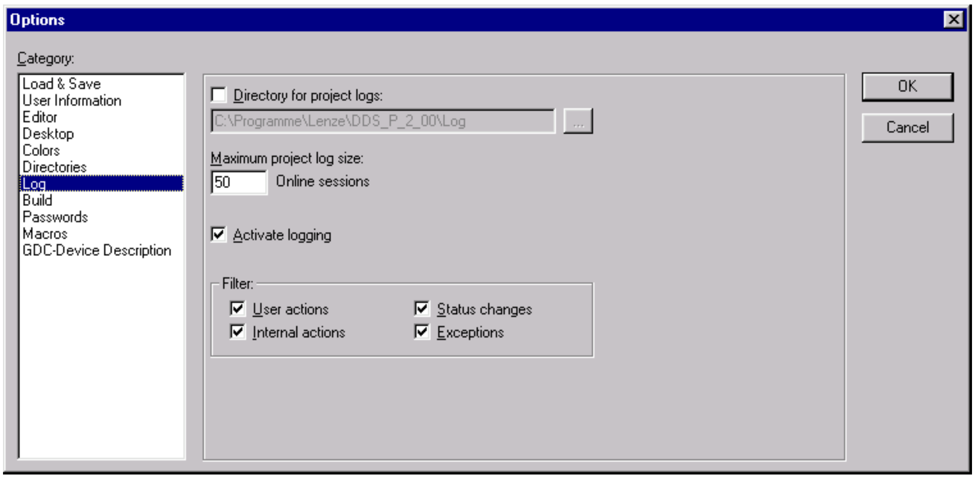
Click (...) behind an input field to open a dialog box for the selection of directories within your directory structure (Browse).For library and configuration files, the system allows the input of several paths each, separated by a semicolon ";". The information will be written to the program system ini file and apply for all projects.

Automation system

This is where the directories for libraries and configuration files are shown that are set in the automation system, through specification in the target file, for example. These windows cannot be edited. An entry can be selected and copied.

DDS searches follow a sequence of project, automation system and common. Where identically named files exist, that in the previously searched directory will be applied.

Options→log



This dialog box allows configuration of a file that chronologically logs all user actions and internal processes in online mode as project log.

The system will open a suitable dialog box if an existing project is opened for which no log has as yet been created. This dialog advises that a log is being created. First input will be made during the next log-in process.

The log is automatically stored as a binary file when the project is saved.
Option **Directory for project logs** offers the option of saving the log in a different directory.

The log is automatically given the name of the project and an extension .log.
Use **Maximum project log size** to define the maximum number of **online sessions** to be logged. If this number is exceeded during logging, the latest input will delete the earliest one.

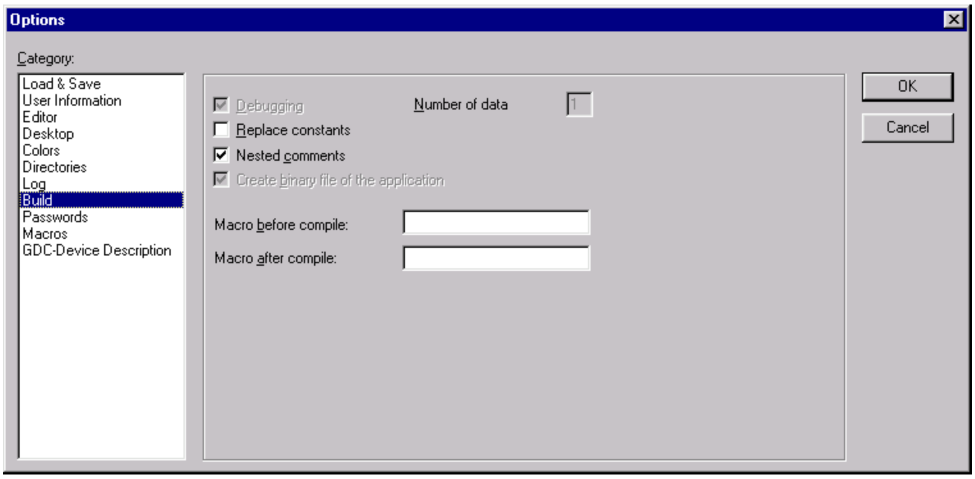
The log function can be switched on and off in the check box **Activate logging**.

Use the group field **Filter** to select the actions to be logged.

- User action
- Internal action
- Status change
- Exception

Only the actions of the selected categories will be displayed in the log window or written to the log.
(📖 6-42)

Options→Build



Debugging

If the option **Debugging** is activated, the code may become noticeably longer since additional debugging code is generated. This is necessary to use the DDS debugging functions. The option is saved together with the project.

- Only if check box **Debugging** is active can breakpoints be set and single stepping is possible.
- If the option **Debugging** is deactivated, the code will be shorter and execution faster.

Replace constants

This option loads the value directly for each constant. In online mode, constants are displayed in green. A constant can then no longer be forced, written or monitored. While the option is deactivated, the value is loaded via variable access to a memory location. Although this allows writing of the variable value, it also means a longer processing time.

Nested comments

This option allows the input of nested comments.

```
 (*
a:=inst.out;(*to be checked*)
b:=b+1;
*)
```

The comment beginning with the first parenthesis is the outer one and completed with the last parenthesis.

Create binary file of the application

Selection of this option means that a binary image of the generated code (boot project) will be created in the project directory during a compile. File name: projectname.bin.

Macro before compile

This option influences the compile process - the macro is run prior to the compile.

Macro after compile

This option influences the compile process - the macro is run after the compile.

Macro commands

The appendix includes a list of all macros.

Command line commands (🕮 15-1)

Command file commands (🕮 15-2)

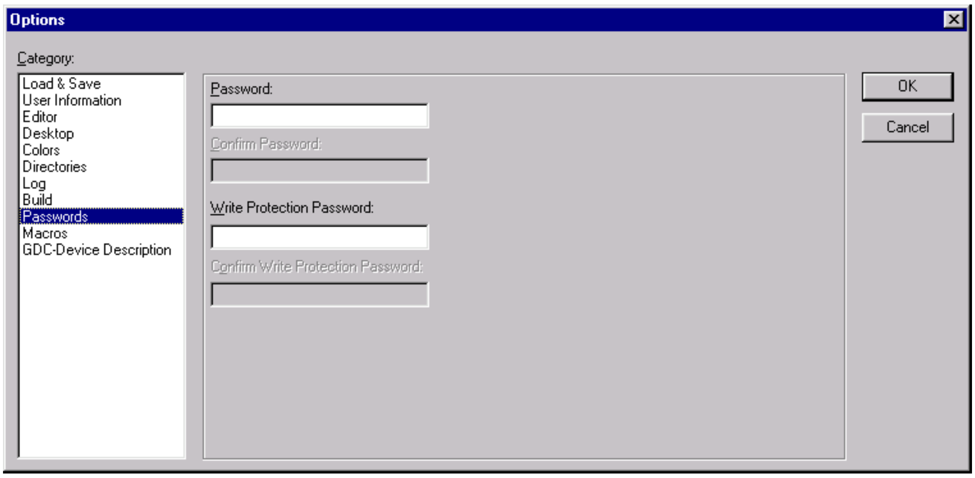
The following macro commands cannot be executed.

```
file new, file open, file close, file save as, file quit, online,
project compile, project check, project build, debug, watchlist
```

For a more detailed description as to how to create macros refer
Options→Macros

All settings defined in the dialog box **Build options** are saved together with the project.

Options→Passwords



The DDS offers password protection for your files against unauthorized access, opening or editing.

Defining a password for opening a file:

1. Enter the required password in text field **Password**.
   Every letter is represented by an asterisk (*).
2. Repeat the password entry in the text field **Confirm password**.
3. Click **OK** to close the dialog box.

If the message "Password and its acknowledgement do not match" appears, one of the two inputs contains a typing error. Retype both entries to ensure that the dialog box closes without any error messages.

When the file is saved and re-opened, a dialog will be displayed for password entry.

The project will only be opened if the password is correct, otherwise the message "The password is not correct" will appear.

Defining a password for editing a file:

Passwords can protect a file from being opened and/or edited:

1. Enter the required password in text field **Write Protection Password**.
   Every letter is represented by an asterisk (*).
2. Repeat the password entry in the text field **Confirm write protection password**.
3. Click **OK** to close the dialog box.

If the message "Password and its acknowledgement do not match" appears, one of the two inputs contains a typing error. Retype both entries to ensure that the dialog box closes without any error messages.

Write protected projects can also be opened without the password.

- To do so, click **Cancel** when the DDS prompts for the write protection password on opening the file. It is now possible to compile the project, load it into the control, simulate it, etc., but it cannot be edited.
- The status bar now includes the display **READ**.

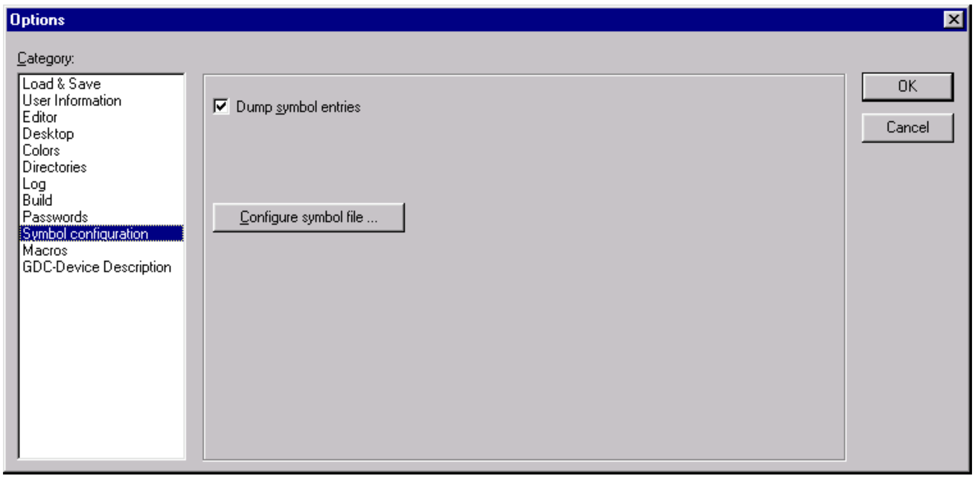
Note!

Make sure to remember the passwords. Contact Lenze if you do forget one of the passwords.

- The passwords are saved together with the project.
- Create user groups to assign more specific access rights.

Options→Symbol configuration

Select the category *Symbol configuration* to open the following dialog box.



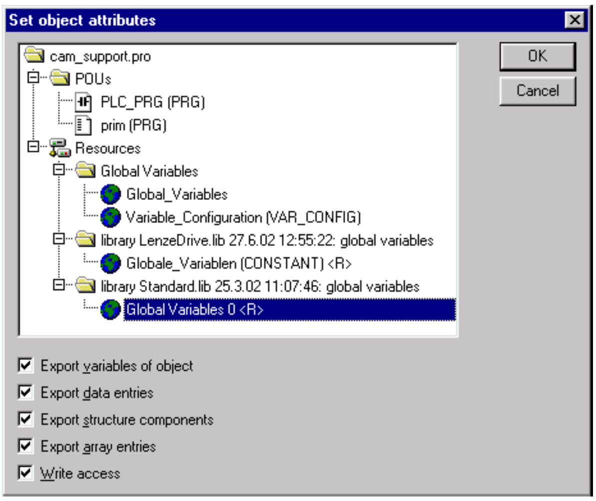
The dialog box assists symbol file configuration (text file*.sym or binary file*.sdb) These are required for data exchange with the control via the symbol interface and are used by Global Drive Oscilloscope for this purpose, for example.

Dump symbol entries

If the check box is activated, every project compile automatically creates symbol entries for the project variables in the file.

Configure symbol file

Use this button to open the dialog box *Set object attribute*.



Select the required project organization units from the tree structure, and tick the required check box.

Export variable of object

The variables of the selected object are output to the symbol file. The other options take effect only if this check box is ticked.

Export data entries

For structures and arrays of the object, entries are generated for access to the overall variables.

Export structure components

For object structures, a separate entry is generated for each variable component.

Export array entries

For object arrays, a separate entry is generated for each variable component.

Write access

The object variables may be modified via the OPC server.

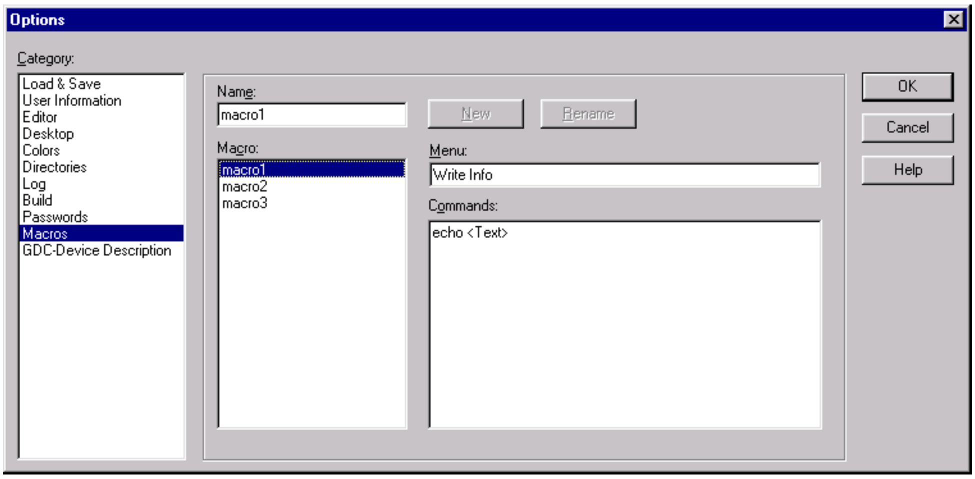
Once the setting is effected for the current organization unit selection, another organization unit can be selected and given different options.

OK

Using this button to close the dialog box means that all changes will be saved.

Options→Macros

Select the category *Macros* to open the following dialog box.



Name

Enter the name for the macro in this text box.

New

Press the button **New** to record the created macro.

Macro

This field lists all created macros. Highlighted macros can be deleted with the **<Del>** key.

Rename

Once an existing macro has been selected in the macro list, it can be renamed via dialog box *Name*. Press the button **Rename** to rename the macro.

Commands

This dialog box defines or edits commands for the macro**.** A new command line is inserted by pressing **<Ctrl>+<Enter>**.The right mouse key displays the shortcut menu with standard editor functions. Components of a command that belong together can be concatenated with the help of quotes.

Macro commands - commands

The appendix includes a list of all macros.

Command line commands (📖 15-1)

Command file commands (📖 15-2)

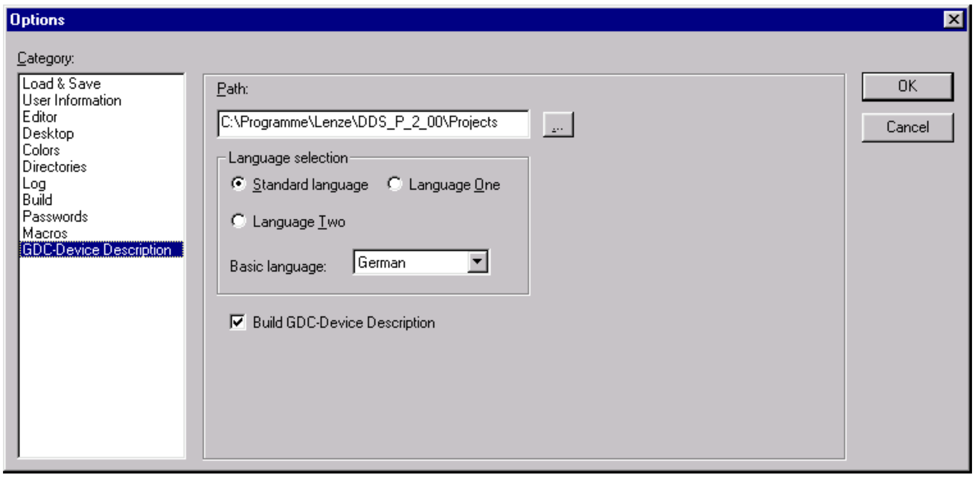
Menu

This dialog box defines the menu entry to insert the macro under
Edit→Macros.
Place an & in front of a letter to turn it into a shortcut. The name **Ma&cro 1** generates menu entry **Macro 1**.

OK

Exits the dialog box and saves the input in the project.
A macro check will be performed only at the time the menu command is executed.

Options→GDC Device Description



Use this dialog box to select whether a project-specific device description file (PDB) is to be created for Global Drive Control (GDC) and, if so, for which languages.

Tip!

A PDB will be created only if a directory has been specified under **Path** and the check box **Build GDC Device Description** has been activated. The PDB is built/updated on project compile if PDB-relevant data have changed.

The file name of the PDB consists of the project name followed by an index (”_S”, ”_1”, ”_2”) for the associated language and the extension ”.pdb”.

Example:

- Name of the project: ”Example”
- Language selection: *Standard language* and *Language Two*
- ⇒ PDB file names: ”Example_S.pdb” and ”Example_2.pdb”

Directory

Use the input field **Path** to determine the directory path for the device description files (PDBs) to be created by the DDS for Global Drive Control.

- Click **...** behind the input field to open a dialog box for the selection of directories within your directory structure (Browse).

Language selection

Select the languages for which to create a PDB.

- Up to three country-specific PDBs can be created per project.
- The associated GDC display texts for the relevant code are defined in the Instance Parameter Manager in the dialog box *More details and information* (call via **Extended** in the Parameter Manager).
- The selected language is identified with a tick. (✓)

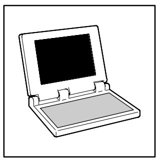
Basic language

The pdb file will be generated in the selected language.

Build GDC Device Description

If check box **Build GDC Device Description** is activated, a PDB for GDC will be built/updated for every language selected under Language selection in the directory specified under *Path* during every project compile.

- This project-specific PDB contains the basic codes for the associated PLC (based on its basic PDB) and the project-specific codes defined in the Parameter Manager.
- It is generated only if PDB-relevant data have changed.
- The device description is also saved into the project directory for easier handling of the Global Drive Loader software.
- If the Lenze OPC server is installed, the device description will also be copied into its PDB directory.



6 Working with projects and objects

6.1 Managing projects

Those DDS commands that refer to the entire project are available in the main menu under **File** and **Project**.

The menu **Project** also contains commands that refer to objects. A detailed description of these commands is included in the chapter "Working with objects".(🕮 6-24)

Note!

Write protection on *.bin file

For each changed or translate project, the corresponding *.bin will be overwritten. This file is saved in the same directory as the project. If this file is write-protected, the project cannot be translated. You have to remove the write protection.

6.1.1 Commands in the "File" menu

6.1.1.1 New

Icon: 	Menu: **File→New**	Keyboard: -

Use this command to a create a blank project called "Untitled". Change the name when saving the project.

6.1.1.2 New, with template

Icon: -	Menu: **File→New, with template**	Keyboard: -

Use this command to create a blank project named "Untitled" including an optional template.

The template has the extension *.lpc and contains a fixed Lenze configuration.

The Lenze configuration includes:

- Program POU
  Organization units with technology function.
- Required libraries
- Global variables
- Entries in the PLC configuration
- Entries in the task configuration
- Predefined user codes
- Visualization and Receipt Manager (as required)

Open the dialog box *Open* and select a template file with the extension "*.lpc".

If the template is protected by **Passwords** or defined with **User groups**, the system will prompt for a password.

6.1.1.3 Open

Icon:	Menu: **File→Open**	Keyboard: **<Ctrl>+<O>**

Use this command to open an existing project.

- If a project has been opened and changed before, the user will be prompted as to whether this project is to be saved or not.

Open the dialog box *Open* and select a project file with the extension ”*.pro” or a library file with the extension ”*.lib”. This file must exist already. The command **Open** does not allow the creation of a new project.

- The menu **File** lists the last-opened projects at the very bottom. Selecting one of those projects will open it.
- If passwords or user groups have been defined for the project, the system will prompt for a password.

6.1.1.4 Close

Icon: -	Menu: **File→Close**	Keyboard: -

Use this command to close the currently open project.

- If the project was changed, the user will be prompted as to whether these changes are to be saved or not.
- If the name of the project to be saved is ”Untitled”, enter a new name.

6.1.1.5 Save

Icon:	Menu: **File→Save**	Keyboard: **<Ctrl>+<S>**

Use this command to save the project if it was changed.

- If the name of the project to be saved is ”Untitled”, enter a new name.

6.1.1.6 Save as

Icon: -	Menu: **File→Save as**	Keyboard: -

Use this command to save the current project under a new name or as library. The original project file remains unchanged.

Selection of the command opens the dialog box *Save as*.

- Select either an existing file name to overwrite an existing project or enter a new file name.
- Select the required file type.

Saving the project under a new name

If the project is to be saved under a new name only, select file type ”DDS Project (*.pro)”.

Then click **OK**.

- The current project will be saved to the selected file. If the new file name already exists, the user will be prompted as to whether this file is to be overwritten or not.

Saving project as library

If the project is to be saved as library for use in other projects, select the file type

- "Internal library (*.lib)" if you programmed your POUs in the DDS.

Then click **OK**.

- The current project will be saved to the selected file. If the new file name already exists, the user will be prompted as to whether this file is to be overwritten or not.
- If the project is saved as library, the entire project will be compiled. Should an error occur, the user will be informed that a correct project is required to generate a library. In such case, the project will not be saved as library.

6.1.1.7 Save/mail archive

Icon: -	Menu: **File→Save/mail archive**	Keyboard: -

DDS has an archive function using which all files of a project (libraries, bitmaps, etc.) can be saved in an archive file.

Note!

To archive a project without the necessity of a compile and download during a later log-in, carry out a download before archiving the project and activate the check box *Compile Information* in the dialog box **Save Archive**.

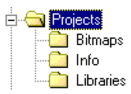
Use this command to generate a ZIP archive file containing all significant DDS project files. The ZIP file can be saved in the file system or e-mailed.

After the ZIP file has been decompressed, you can log in a controller without prior download.

Note!

Proceed as follows to use the ZIP archive in this way:

1. The corresponding files (libraries, bitmaps, etc.) of a project must be created relative to the project.



2. Open the following dialog using the menu command **Project→Options** category *Directories* and enter just "**.**" in the field Libraries. The input fields **Compile files** and **Configuration files** remain empty.

Note!

Paths which have been assigned a disk drive (SUBST[Disk drive1: Disk drive2:]Path) are not supported.

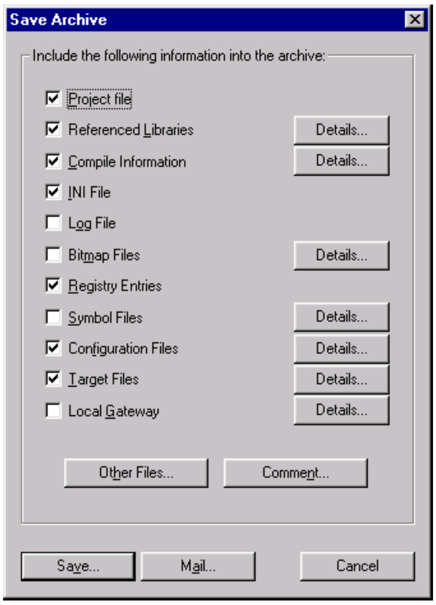
Do not use the SUBST Windows function.

3. Compile the project.

Note!

After compiling the project must be saved once. While the project is saved, DDS creates files which are part of the ZIP archive.

4. Open the following dialog with the menu command **File→Save/mail archive**. Only tick (project file, referenced libraries, compile information and bitmap files). This menu item can only be ticked if a bitmap is contained in the project. If no bitmaps are contained, you can ignore this item.



5. If you have ticked the items save the archive.

Include the following information into the archive

Apart from the procedure described, the ZIP archive can also be used in general.

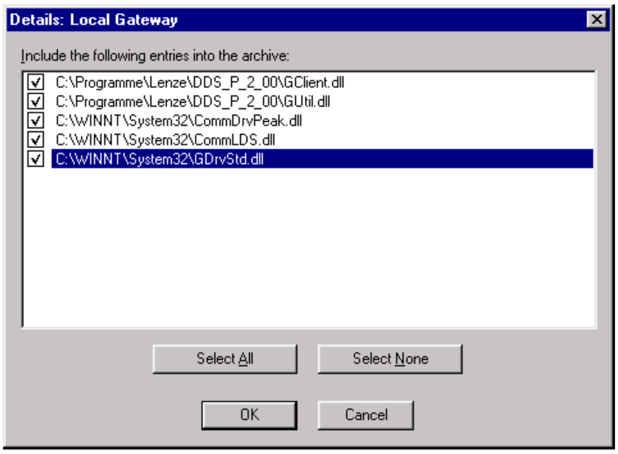
A category must be selected with (✓).

Category	Relevant files
Project file	<project name>.pro (the DDS project file)
Referenced libraries	*.lib, *.obj, *.hex (libraries and, if necessary, the associated obj and hex files)
Compile information	*.ci (information specific to the last compile) *.ri (information specific to the last download) <temp>.* (temporary compilation and download files) also for simulation
INI file	DDS.ini
Log file	*.log (project log file)
Bitmap files	*.bmp (bitmaps used in project organization units and visualizations)
Registry entries	Registry.reg (entries for Automation Alliance, gateway and PLC)
Icon files	*.sdb, *.sym (icon information generated from the project)
Configuration files	PLC configuration files (configuration files, device master files, icons, etc.) e.g. *.cfg *.con *.eds *.dib *.ico...
Target files	*.trg (binary-format target files for all installed targets) *.txt (binary-format target files for all installed targets, if available)
Local gateway	Gateway files: Gateway.exe, GatewayDDE.exe, GClient.dll, GDrvBase.dll, GDrvStd.dll, Ghandle.dll, GSymbol.dll, GUtil.dll and other DLLs in the gateway directory

Details

Use the button **Details** to request a dialog box for the direct selection of information on the respective category.

The dialog box *Details* is explained on the basis of *Details: Local gateway*.



The dialog box shows the local gateway details that can be selected directly with (✓). Use the button **Select all** to select everything. **Select none** removes the ticks. Confirm with **OK**.

Other files

Use the button **Other files** to open a dialog box to transfer user-defined files into the archive.

Comment

The button opens a text editor to generate a README.TXT file that contains the specified text which is automatically extended by the generation date and the version number of the currently used DDS version.

Generating the ZIP archive

The ZIP archive can be generated once all settings have been made and checked.

Save

A ZIP file is generated and saved and can be stored at the desired location with the help of the Windows dialog. The file default name is projectname.zip. Pressing the button **Save** starts archive generation where the process is logged in the message window along with a progress bar display.

Mail

A blank e-mail is generated with the project attached as a ZIP file. This function requires correct MAPI (Messaging Application Programming Interface) installation.

Cancel

The process is cancelled. No settings are saved.

6.1.1.8 Print

Icon:	-	Menu:	**File→Print**	Keyboard:	**<Ctrl>+<P>**

Use this command to print the contents of the active window.

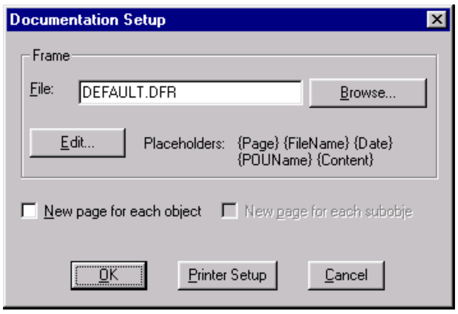
Selection of the command opens the dialog box *Print*.

- Select the required option and click **OK**. The active window will be printed. Every editor can be colour-printed.
- Use the button **Properties** to open the dialog box *Printer setup*.
- The layout of your printout can be defined under **File→Documentation setup**.
- During the printout, the number of pages already printed will be displayed in a dialog box. The printout will be stopped after the next page if this dialog box is closed.
- To document your entire project, use the command **Project→Document project**.
- To generate a document template for your project to specify the comments for all variables used within the project, open a global variable list and use the command **Extras→Create document template**. (🕮 8-3)

6.1.1.9 Documentation setup

Icon:	-	Menu:	**File→Documentation setup**	Keyboard:	-

Use this command to specify the layout of the pages to be printed.



File

Use text field **File** to enter the name of the file with the extension ".dfr" to save the page layout to.

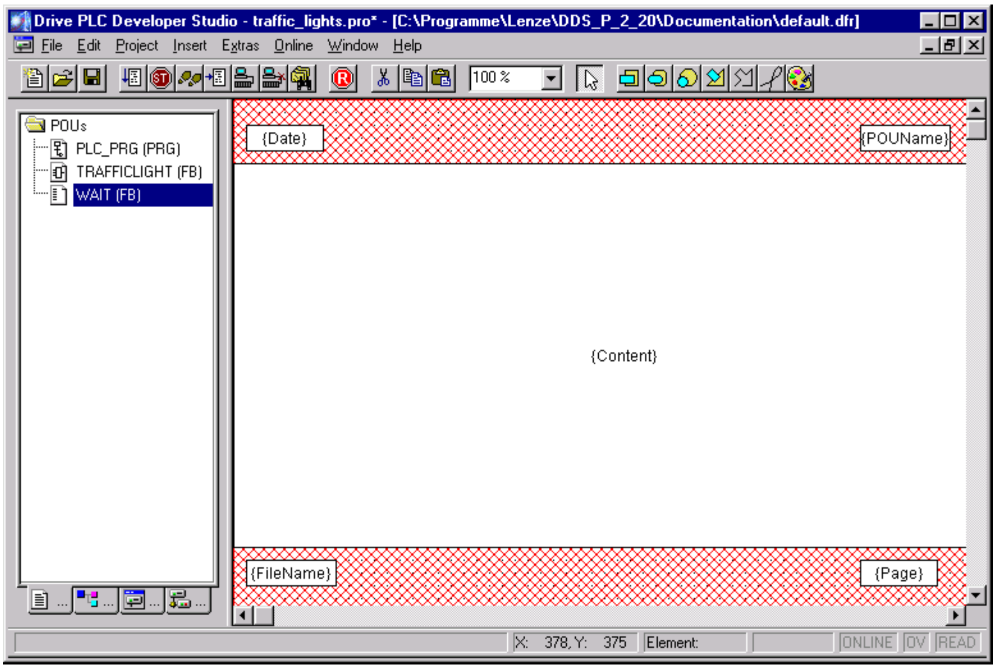
- By default, the template is saved in the file "DEFAULT.DFR".
- To change an existing layout, click **Browse** to find the required file in your directory structure.

Edit

Select **Edit** to display the page layout template. Arrange the placeholders for page numbers, date, names for files and organization units as well as on-page graphics and define the text zone to print the documentation in.

Tip!

Use the button **Printer setup** to open the dialog box *Printer setup* to effect documentation settings.



Use the command **Insert→Placeholder** to select one of the five placeholders to be inserted into the layout by simply drawing a rectangle and move it to the desired position, if necessary.

Placeholders will be substituted as follows in the printout:

Command	Placeholder	Effect
Page	{Page}	The current number of pages is printed.
POU name	{POUName}	The name of the current organization unit.
File name	{FileName}	The name of the project.
Date	{Date}	Current date.
Content	{Content}	The contents of the organization unit.

Use **Insert→Bitmap** to insert a bitmap (e.g. a company logo) into the page. Select a bitmap and draw a rectangle in the layout with the mouse. Further visualization elements may be inserted as well.

New page for each object/New page for each subobject

Select whether a new page is to be started for each object and subobject.

Printer setup

Use the button **Printer setup** to open the dialog box *Printer setup* to specify printer, paper format, etc.

OK/Cancel

Click **OK** to accept the changes or **Cancel** if you do not want to save them.

If the template has been changed, the user will be prompted on closing the window as to whether the changes are to be saved or not.

6.1.1.10 Exit

Icon: -	Menu: **File→Exit**	Keyboard: **<Alt>+<F4>**

Use this command to exit the DDS.

- If a project has been opened and changed, the user will be prompted as to whether this project is to be saved or not.

6.1.2 Commands in the "Project" menu

6.1.2.1 Compile

Icon: -	Menu: **Project→Compile**	Keyboard: **<F11>**

Use this command to compile the project to check your program's syntactic correctness. The compile is incremental, only those organization units that have been modified will be recompiled. A non-incremental compile requires prior execution of the command **Project→Clean all**.

Automation systems that support online change identify all organization units with a blue arrow in the Object Manager after the compile. These will be loaded to the control during the next download.

The compile performed with **Project→Compile** will be executed automatically on **Online→Log in**

Errors and warnings are identified with numbers.

```
Data allocation
Check of the task configuration
Library 'Standard.lib 25.3.02 11:07:46'
Library 'LenzeDrive.lib 27.6.02 12:55:22'
Generating prolog
Implementation of POU 'PLC_PRG'
Error 3728: PLC_PRG (1): Invalid address: '%IX2.7'
Error 3728: PLC_PRG (1): Invalid address: '%IX2.8'
Error 3728: PLC_PRG (1): Invalid address: '%IX2.0'
Error 3728: PLC_PRG (1): Invalid address: '%QX3.0'
Hardware-Configuration
4 Error(s), 0 Warning(s).
```

Use the command **Project→Options**, category ***Load & Save***, check box **Save before compile** to save the project prior to the compile.

Tip!

Cross references are created during the compile and will not be saved among the compile information!

To apply the commands **Output call up tree**, **Output cross reference list** and the commands **Output unused variables**, **Concurrent access** and **Multiple write access on output** of the menu **Project →Check**, the project must be recompiled after a change.

6.1.2.2 Compile all

Project→Compile all, contrary to **Project→Compile**, recompiles the complete project, **not** deleting the download information in the process.

The menu command **Project→Clean all** deletes the download information.

6.1.2.3 Clean all

Note!

A log-in without another project download is possible only if the file *.ri containing the project information of the last download was explicitly stored outside the project directory before and can be reloaded prior to log-in.

Execute the menu command **Project→Load download information**.

Icon: -	Menu: **Project→Clean all**	Keyboard: -

This command clears the information of the last download and the last compile. Once the command has been executed, the system displays a dialog to advise that no log-in is possible without another download. You can continue or cancel the process at this point.

6.1.2.4 Load download information

Icon: -	Menu: **Project→Load download information...**	Keyboard: -

Use this command to directly reload the associated download information as long as the information was not stored in the project directory. The standard dialog
File→Open allows the direct loading of stored information.

- On each download, the download information is automatically put into a file **project name Targetidentifier.ri**. Example: LD_FillingPlants00000000r.ri and included in the project directory.
- It will be reloaded automatically every time the project is opened and allows the control to perform an ID check to establish whether the project on the control matches the open project.
- A check is made to find those organization units whose generated code has changed. Only these organization units are reloaded during downloads for systems supporting online change.

If the *.ri file was deleted from the project directory via the menu command **Project→Clean all**, the download information can be explicitly loaded from another directory with **Project→Load download information...**.

6.1.2.5 Translate into other languages

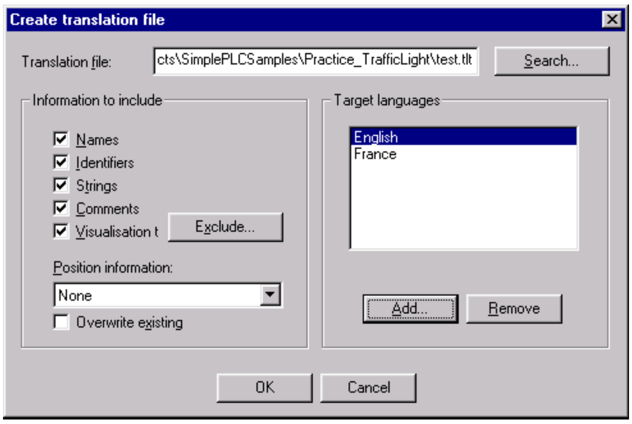
Icon: -	Menu: **Project→Translate into other languages**	Keyboard: -

This menu item translates the current project file into a different national language by reading a translation file generated from the project. The translation file will then be updated with translated texts in the desired national language with the help of a text editor.

For this purpose, the menu offers two subitems.

- **Project→Translate into other languages→Create translation file**
- **Project→Translate into other languages→Translate project into another language**

Creating a translation file



- Enter a path in the field **Translation file** to store the file at the desired location. The standard file extension is *.tlt (text file).
- To edit an existing translation file, select and open it with the Windows dialog **Search**.
- Optionally, the following information can be included with the generated or modified translation file:
  – Name, titles in the Object Organizer
  – Identifiers
  – Strings, comments, visualization
  – Position information

If the relevant options are ticked (✓), the information will be included as linguistic symbols from the current project into a translation file that either already exists or needs to be created, or updated in an existing one. If the relevant option is not selected, all information of the individual category, no matter from which project, will be removed from the translation file.

The visualization texts in this case are the elements **Text** and **Tool tip text** of the visualization elements.

Tip!

Note for the visualization texts **Text** and **Tool tip text** of the visualization elements that they must be framed by two # characters in the configuration dialog of the visualization element `#text#` to be included in the translation file. (🕮 9-1)

Position information

This uses the data of file path, organization unit and line to describe the position of the linguistic symbol provided for translation.

Three options are available:

- **None** No position formatting is generated.
- **First occurrence** The position at which the element to be translated first occurs, will be included in the translation file.
- **All** All positions at which the relevant element occurs in the project are specified.

Where an older translation file is edited that already contains more position information than selected here, this information will be reduced accordingly or deleted in full, independent of the project in which it was generated.

Tip!

A maximum of 64 position information items will be generated for each element (linguistic symbol), even if the dialog box *Create translation file*, combination box **Position information**, specifies All.

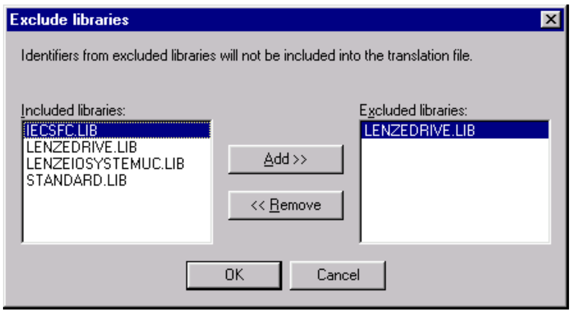
Overwrite existing

All existing position information in the translation file being edited is overwritten, independent of the project in which it was generated.

This list contains identifiers for all languages in the translation file and that are to be included on exiting the dialog *Create translation file*.

Exclude

The button **Exclude** opens the dialog box *Exclude libraries*.



Here those project libraries can be selected whose user information is not to be accepted into the translation file.
Use the buttons **Add and Remove** to determine which libraries to exclude and which to include. Confirm with **OK**. The dialog box closes.

Target languages

The button **Add** in the group box **Target languages** opens the dialog box *Add target languages*.

This is where you can add other languages. Enter English(USA), for example, and confirm with **OK**. The entered language must not have any white spaces or umlauts at the beginning and the end. The button **OK** will be greyed out if the input is not acceptable or incomplete.

The button **Remove** in the group box **Target languages** deletes a language from the list, removing only the selected language.

Creating a translation file

Press **OK** in the dialog box *Create translation file* to generate a translation file. The system will first check whether there already exists another translation file with the same name.

Select **No** to return to the dialog box *Create translation file*.
Select **Yes** to generate a copy of the existing translation file with the file name Backup_of_translation file.tlt.

A translation file is generated as follows:

- A placeholder **##TODO** is generated for each new target language for each linguistic symbol to be output.
- If an already existing translation file is being processed, any data entries of languages listed in the translation file, but not in the target language list, will be removed, independent of the project in which they were generated.

Editing a translation file

Open and save the translation file as a text file. Characters ## identify keywords. The ##TODO placeholders in the file may be substituted with the applicable translated texts. A section delimited by ##NAME_ITEM and ##END_NAME_ITEM is created for each linguistic symbol (comments: ##COMMENT_ITEM etc.).

Find below a sample section in the translation file for the name of the organization unit ST_Visu. Target languages are English(USA) and French. The position information for the project element to be translated was also included in this example.

Prior to the translation

```
##NAME_ITEM
[D:\DDS\projects\Bspdt_22.pro::ST_Visualisierung::0]
ST_Visualisierung
##English :: ##TODO
##French :: ##TODO
##END_NAME_ITEM
```

After the translation

##TODO was substituted with the English and French expressions.

```
##NAME_ITEM
[D:\DDS\projects\Bspdt_22.pro::ST_Visualisierung::0]
ST_Visualisierung
##English :: ST_Visualization
##French :: ST_Visu
##END_NAME_ITEM
```

Make sure that translated identifiers and names remain valid under the standard and that strings and comments are placed within the relevant brackets.

Note!

The following blocks of the translation file should not be modified without detailed knowledge.

Language block, flag block, position information, original texts

6.1.2.6 Translate this project

Icon: -	Menu: **Project→Translate this project**	Keyboard: -

This menu command offers subitems

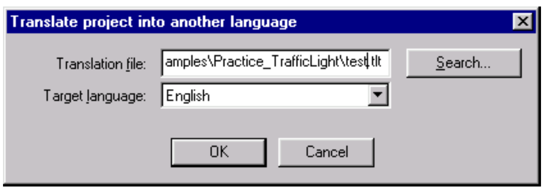
- Create translation file
- Translate project into another language

Tip!

The translate cannot be undone. Save a project copy under a different name before translating.

Creating a translation file

Translating a project into another language



The current project can be translated into a different language, using a valid translation file.

Translation file

Specify the translation file path in this text field.

Search

This button takes you to the Windows file selection dialog.

Target language

This combination box offers the language identifiers to select the target language.

OK

The button starts the translate of the current project with the help of the specified translation file into the selected target language. Progress and any error messages will be displayed during the translate. After the translate, the dialog box and all other open dialog windows will be closed.

Cancel

The button closes the dialog box without saving changes.

Should there be incorrect entries in the translation file, pressing **OK** will output an error message with file path and incorrect line.
[C:\Program files\DDS\projects\visu.tlt(78)]; expect translated text.

6.1.2.7 Document project

Icon: -	Menu: **Project→Document project...**	Keyboard: -

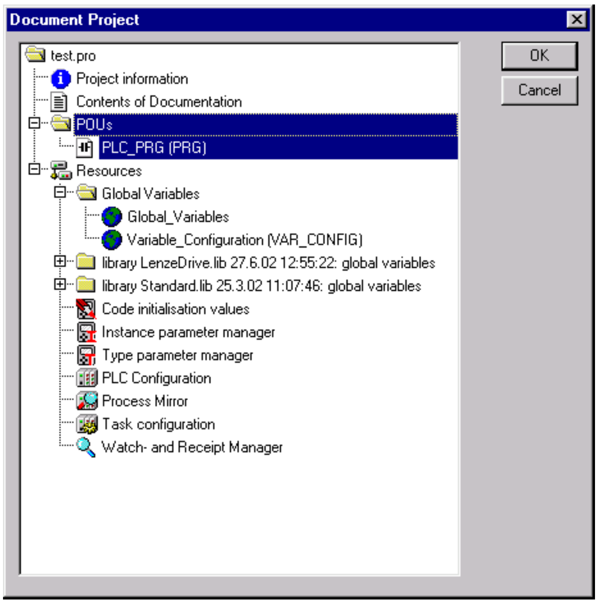
Use this command to print the documentation for an entire project.

Complete documentation comprises:

- Contents of the documentation
- Organization units
- Data types
- Call trees of organization units and data types
- Visualizations
- Resources (global variables, variable configuration, PLC configuration, task configuration, Watch and Receipt Manager)
- Cross reference list
- Table listing the codes assigned via the Parameter Manager

Documentation of ”Call up trees” and ”Cross reference list” requires an error-free project compile.

Command selection opens a dialog box to select the objects to be printed:



- Make your selection and click **OK**.
- The dialog box *Print* is opened.
- The layout of the pages to be printed can be defined under **File→Documentation setup**.

6.1.2.8 Export

Icon: -	Menu: **Project→Export...**	Keyboard: -

The DDS offers the option of exporting and importing projects so that programs can be exchanged between different IEC programming systems.

- There is so far one standardized exchange format for organization units in IL, ST and SFC (IEC 61131-3 Common Elements Format).
- The DDS offers a separate save format for organization units in LD and FBD and the other objects as IEC 61131-3 does not provide any appropriate textual format. The selected objects are written to an ASCII file.
- Organization units, data types, visualizations and resources can be exported.
- In addition to that the entries in the Library Manager, i. e., the library linking information, can also be exported. The libraries themselves are not exported.

Command selection opens a dialog box to select the objects to be exported.

- Make your selection and click **OK**.
- The dialog box *Save* is opened. Enter a file name with the extension ".exp".

6.1.2.9 Import

Icon: -	Menu: **Project→Import...**	Keyboard: -

Select the required export file from the dialog box.

The data are imported into the current project. If an identically-named object already exists in the project, the dialog box "Do you want to replace?" appears.

- Confirm with **Yes** to replace the object in the project with the object from the import file.
- Confirm with **No** to import the object from the import file with a name extension (underscore and consecutive number "_0", "_1", ...).
- Confirm with **Yes, all** or **No, none** to apply the actions described before to **all** objects.

The message window logs the import.

Note!
The following resource elements will be exported incompletely or not at all.

- Code initialization values
- Instance Parameter Manager
- Type Parameter Manager
- Task configuration

6.1.2.10 Compare

Icon: -	Menu: **Project→Compare...**	Keyboard: -

Use this command to compare
– two projects
– an open project with the one last saved. Do not save to allow the changes to be displayed.

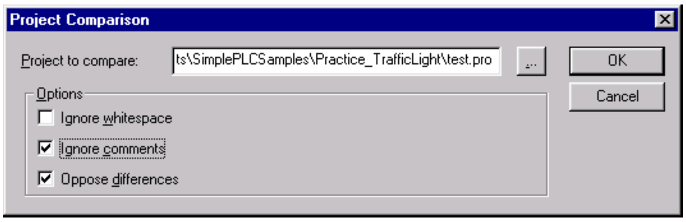
Tip!
If the compare mode is active (status bar: Compare), the project cannot be edited.

Conventions

Designation	Meaning
Current project	The project currently edited
Project to compare	The project called for the compare
Compare mode	If **Project→Compare** was selected, the project is in compare mode
Unit	The smallest compare unit

In compare mode, the current and the compare objects will be displayed in a split window. The editor organization units offer the possibility of a directly-aligned content compare. Filters can be activated prior to the compare.

Comparing projects



Project to compare

By default, this text field contains the path of the project to compare.

Ignore white space

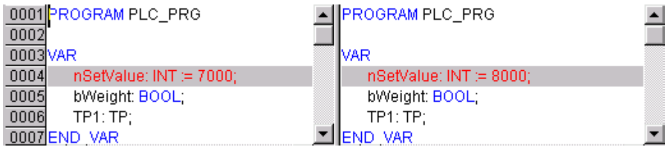
No differences in the white spaces will be displayed if the check box is active.

Ignore comments

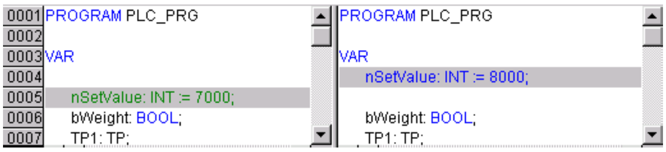
No differences in the comments will be displayed if the check box is active.

Oppose differences

Units that were changed, but not deleted, will be displayed if the check box is active. The numerical value in line 4 was changed. 7000 is the change, 8000 the original value.

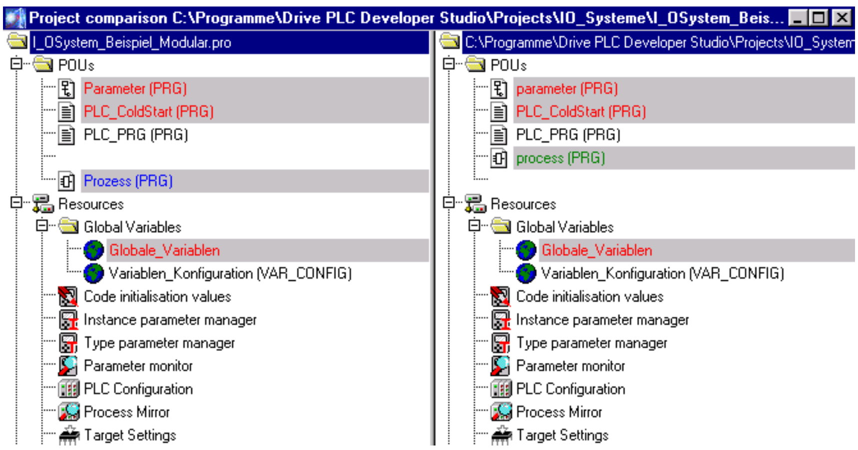


The values will not be directly aligned if the check box is not active.



Result display

The results are first displayed in a directory tree. A double-click will open the individual organization unit to show the highlighted changes.



Colours

Any differences are marked by coloured text.

Red
Unit was modified and is displayed in red in both window panes.

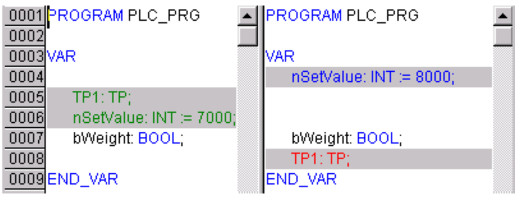
Blue
Unit exists only in the project to compare. The current project contains a space.

Green
Unit exists only in the current project. A space is inserted in the project to compare.

Black
No differences in unit.

The following text can appear after the organization units of the current project:

- (Properties modified)
  This text appears after a name of an organization unit if the properties of the organizations unit differ.
- (Access authorizations modified)
  This text appears after an organization unit if the access authorizations differ.



6.1.2.11 Copy

Icon: -	Menu: **Project→Copy**	Keyboard: -

Use this command to copy objects (organization units, data types, visualizations and resources) and links to libraries from other projects into the current project.

Selection of the command opens the dialog box *Copy project*.

1. Find the project from which you want to copy objects to the current project.
2. Click **Open** to open the project.

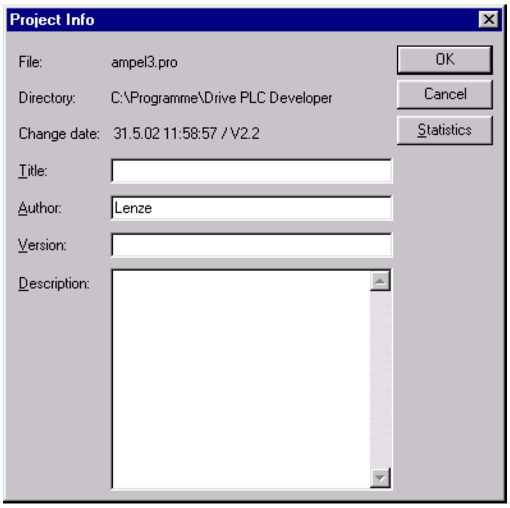
This will open a dialog box for object selection.

- If there already exists an object with the same name within the project, the name of the new object will be entered with an underscore and a number (”_1”, ”_2”, ...) as the last characters.

6.1.2.12 Project information

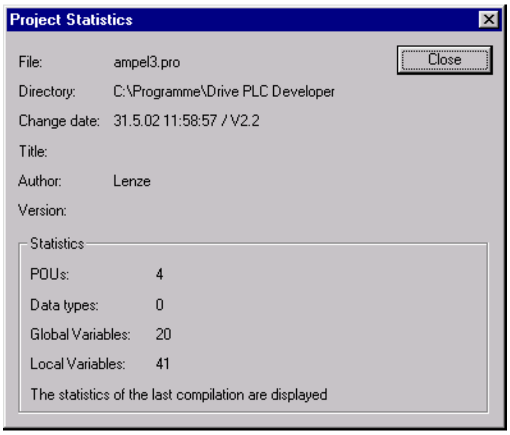
Icon:	-	Menu:	**Project→Project information**	Keyboard:	-

Use this command to save information about the project.



Statistics

Click the button **Statistics** for statistical information about your project.



The statistics contain project information, number of POUs, data types, local and global variables as saved on the last compile.

- Select the dialog box *Option*, category *Load & Save* and there **Ask for project information** to obtain project information automatically when a new project is stored or an already existing project is saved under a new name.

6.1.2.13 Global search

Icon:		Menu:	**Project→Global search**	Keyboard:	-

Use this command to find text in organization units, data types or objects of the global variables.

Command selection opens a dialog box to select the required objects.

Confirm the selection with **OK** to open the dialog box *Find*.

- If a text is found in an object, the object will be loaded into the associated editor and its occurrence displayed.
- Display of the found text, Find and Find next are analogous to the menu command **Edit→Find**.

Find what

Enter the required character sequence. If a text is found in an object, the object will be loaded into the associated editor or Library Manager and its occurrence displayed.

Message window

Pressing this button lists all occurrences of the character sequence in question within the selected objects line-by-line in the message window and displays an occurrence total.

The following information is displayed.

- Object name
- Occurrence in the declaration part or implementation part of an organization unit
- Line or network number
- Complete line for text editors
- Complete text unit for graphic editors

The message window can display the following information for a requested character sequence "bottom".

Global search
ST-EXAMPLE (PRG-ST)(declaration) #5 bottom: INT:= -250;
ST-EXAMPLE (PRG-ST)(implementation) #14 bottom :=yVal + offset;
ST-EXAMPLE (PRG-ST)(implementation) #19 IF (bottom >-250) THEN
ST-EXAMPLE (PRG-ST)(implementation) #20   bottom := Bottom -offset;
The character sequence 'bottom' was found 4 times.

A double-click on one of the lines opens the associated editor and highlights the line with the character sequence. Function keys **<F4>** and **<Shift>+<F4>** allow toggling between the output lines.

Note!

Not implemented for Parameter Manager and code initialization.

6.1.2.14 Global replace

Icon: -	Menu: **Project→Global replace**	Keyboard: -

Use this command to find text in organization units, data types or objects of global variables and replace it with another text.

The libraries are not available for selection, and no output is possible into the message window.

Command selection opens a dialog box to select the required objects.

Confirm the selection with **OK** to open the dialog box *Global replace*.

Find next

- The occurrence is displayed if the text in the combination box **Find what** is found in one of the objects to be searched.

Replace

- The current occurrence of the text in the combination box **Find what** found in the objects to be searched is replaced with the text in the combination box **Replace with**.
- The highlight will jump to the next occurrence after the replace.

Replace all

- All occurrences of the text in the combination box **Find what** found in the objects to be searched are replaced with the text in the combination box **Replace with**.

Cancel

- Closes the ”Find and replace” function.

Note!
Not implemented for Parameter Manager and code initialization.

6.1.2.15 Project check

Icon: -	Menu: **Project→Check**	Keyboard: -

This menu command offers four separate subitems:

- Unused variables
- Overlapping memory areas
- Concurrent access
- Multiple save on output

The results are output in the message window.

Each of these four functions checks the status of the last compile. In other words, a project must have been compiled correctly at least once. The menu items will not be active if that is not the case.

Unused variables

This function looks for declared variables that are not used in the program. They are output with organization unit name and organization unit line.
Example: PLC_PRG (4) - var1
Variables in libraries will not be considered.

Overlapping memory areas

This function checks overlapping of specific memory areas during variable assignment with the help of the AT declaration.

Example:
Assignment of variables

```
var1 AT %QB21: INT
var2 AT %QD5: DWORD
```

causes an overlap as they occupy byte 21 at the same time. Output is then as follows:

%QB21 is referenced by the following variables:

```
PLC_PRG (3): var1 AT %QB21
PLC_PRG (7): var2 AT %QD5
```

Concurring access

This function looks for memory areas that are referenced in more than one task. No difference between read and write access. Output is then as follows:

%MB28 is referenced in the following tasks:

```
Task1 - PLC_PRG (6): %MB28 [read-only access]
Task2 - POU1.ACTION (1) %MB28 [write access]
```

Multiple save on output

This function looks for memory areas that are accessed at several locations within a project. Output is then as follows:

%QB24 is described at the following locations:

```
PLC_PRG (3): %QB24
PLC_PRG.POU1 (8): %QB24
```

6.1.3 User groups

The DDS allows up to eight groups to be set up with different access rights to organization units, data types, visualizations and resources.

Access rights can be defined for individual or all objects.

- All projects are opened by a member of a specific user group.
- The member must authenticate himself with a password.

The user groups are numbered from 0 to 7, with group 0 having administrator rights, i. e., only group 0 members must define passwords and access rights for all groups or objects.

- New projects are initially not password-protected.
- As long as no password has been set up for user group 0, everybody who opens the project is a member of user group 0.
- If a password has been set up within a project for user group 0, all groups are prompted for a password when opening the project.

1. Use the combination box **User group** to select the group you belong to.
2. Use the text field **Password** to enter the password.
3. Click **OK** to accept the input.

If the password does not match the saved password, the message “The password is not correct.” will be displayed.

- Only correct password entry will open the project.

Caution!

A project may be opened via a user group that was not assigned a password.

- Use the menu item **Project→User group passwords** to assign passwords.
- Use the menu item **Project→Objects→Access rights** to assign rights for individual or all objects.

6.1.3.1 User group passwords

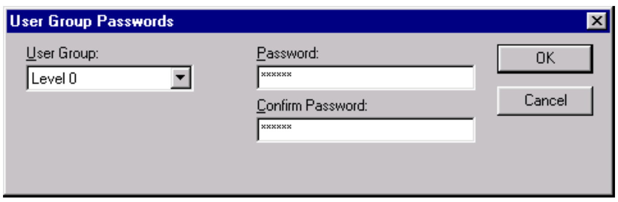
Icon: -	Menu: **Project→User group passwords**	Keyboard: -

Use this command to open the dialog box *User group passwords*.

Note!

This command can only be executed by members of group 0 (administrators).

Dialog box ”*User group passwords*”



1. Use the combination box **User group** to select the group to assign a password to.
2. Use the text field **Password** to enter the password. Every letter is represented by an asterisk (*).
3. Repeat the entry in text field **Confirm password**.
4. Click **OK** to accept the input.

If the message “Password and its acknowledgement do not match.” appears, one of the two inputs contains a typing error.

- Retype both entries to ensure that the dialog box closes without any error messages.

If necessary, assign a password for the next group only then by requesting the command again.

Tip!
Use the command **Object→Access rights** to assign rights for individual or all objects.

6.1.3.2 Exception handling

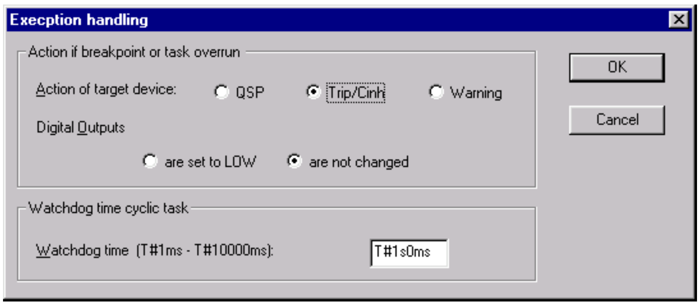
Icon: -	Menu: **Project→Exception handling**	Keyboard: -

Use this command to open the dialog box *Exception handling* where the watchdog time for the cyclical task and the general response of the selected automation system during a task overflow can be defined. (📖 8-31)

The layout of the dialog box *Exception handling* depends on the settings of the automation system. (📖 8-38)

Servo PLC

Automation system with drive function

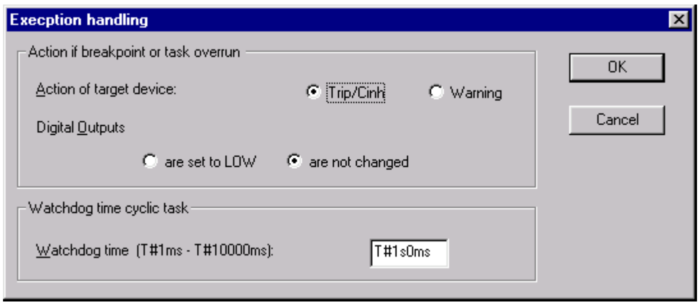


Note!
The configuration of the digital outputs
– gets lost with the extension modules.
– remains unchanged with the Servo PLC.

	QSP	Trip/CINH	Warning
Event during program processing	Response of the automation system		
PLC stop, breakpoint	• Fail QSP is activated • Code C168, subcode 1 Error entry: none	• CINH is activated • Code C168, subcode 1 Error entry: none	• Motor continues running • Code C168, subcode 1 Error entry: none
Task overflow	• Fail QSP is activated • Code C168, subcode 1 Error entry: Task overflow	• CINH is activated • Code C168, subcode 1 Error entry: Task overflow	• Motor continues running • Code C168, subcode 1 Error entry: none

Drive PLC

Automation system without drive function



Note!

The configuration of the digital outputs
– remains unchanged with the extension modules.
– remains unchanged with the Drive PLC.

	QSP	Trip/CINH	Warning
Event during program processing	Response of the automation system		
PLC stop, breakpoint		• CINH is activated • Code C168, subcode 1 Error entry: none	• Motor continues running • Code C168, subcode 1 Error entry: none
Task overflow		• CINH is activated • Code C168, subcode 1 Error entry: Task overflow	• Motor continues running • Code C168, subcode 1 Error entry: none

6.2 Working with objects

This chapter describes how to work with objects and the help functions available to keep an overview of a project (folders, call tree, cross reference list, etc.).

6.2.1 Object

"Objects" are organization units, data types, visualizations and resources, global variables, PLC configuration, task configuration and Watch and Receipt manager etc.

- Some of the folders inserted for project structuring are included in the project.
  An example of these is the organization unit folder with the action PLC_PRG.
- All objects of a project are saved in the *Object Organizer*.

Tip!
Positioning the mouse pointer briefly over an organization unit in the *Object Organizer* will display a tool tip with the type of the organization unit (program, function or function block).

Objects and folders can be moved within their object type with Drag & Drop. Use this Windows function to select objects and to move them while keeping the left mouse key depressed. Should the move result in a name collision, an error message is displayed and the process ignored. However, it is possible to generate an identically named subfolder within a folder.

6.2.1.1 Selecting objects

Selected objects are highlighted in blue.

Selecting the entire project

To select the entire project, select the project name in the first line.

Selecting individual objects

To select individual objects, click the associated object or move the dotted rectangle over the object with the help of the arrow keys.

Objects with a plus sign in front of their icon are organization objects that contain further objects.

Click a plus sign to open the organization object, and click the minus sign to close it again.

Selection of an organization object also selects all associated objects.

Selecting an object range

Keep the **<Umschalt>** key depressed to select a range of objects.

Selecting several individual objects

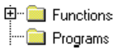
Keep the **<Ctrl>** key depressed to select several individual objects.

6.2.2 Folders

To keep an overview in the case of larger projects, organization units, data types, visualizations and global variables in the *Object Organizer* should be saved in folders.

- Folders can be nested to any depth.
- Insert new folders with the command **New folder**.

A plus sign in front of the closed folder icon indicates that this folder contains objects and/or other folders.

	A click on the plus sign opens the folder and displays all subordinate objects.
	A minus sign appears instead of the plus sign. Click on the minus sign to close the folder again.

The shortcut menu contains the commands **Expand node** and **Minimize node** which have the same functionality.

Drag & Drop

Drag & Drop moves objects and folders within their object type.

- To do so, select the object and move it to the desired position while keeping the left mouse key depressed.

Tip!

Folders do not influence the program. All they do is structure projects.

6.2.3 Commands in the shortcut menu

6.2.3.1 New folder

Icon: -	Menu: **Shortcut menu→New folder**	Keyboard: -

Use this command in the shortcut menu of the *Object Organizer* to insert a new folder as object.

- If a folder is selected, the new folder will be inserted thereunder, otherwise at the same level.
- If an action is selected, the new folder will be inserted at the organization unit level where the action is linked.
- To open the shortcut menu, select an object or the object type and press the right mouse key or **<Umschalt>+<F10>**.

Folder naming convention

- Newly inserted folders are identified **New folder**.
- Folders and objects cannot bear identical names at the same level.

6.2.3.2 Expand node

Icon: -	Menu: **Shortcut menu→Expand node**	Keyboard: -

Use this command in the shortcut menu of the *Object Organizer* to display the objects underneath the selected object.

- Folders can also be opened and closed with a double-click or pressing **<Enter>**.
- To open the shortcut menu, select an object or the object type and press the right mouse key or **<Umschalt>+<F10>** .

6.2.3.3 Minimize node

Icon: -	Menu: **Shortcut menu→Minimize node**	Keyboard: -

Use this command in the shortcut menu of the *Object Organizer* to hide the objects listed underneath the selected object.

- Folders can also be opened and closed with a double-click or pressing **<Enter>**.
- To open the shortcut menu, select an object or the object type and press the right mouse key or **<Umschalt>+<F10>**.

6.2.4 Commands in the “Project” menu

6.2.4.1 Delete object

Icon: -	Menu: **Project→Delete object**	Keyboard: **<Del>**

Use this command to delete the currently selected object or folder with its objects from the *Object Organizer* and thus the project.

- The user will be asked to confirm the delete.
- If the editor window of the object was open, it will be closed automatically.
- If the menu command **Edit→Cut** is used to delete an object, the object will be saved to the clipboard.

6.2.4.2 Insert object

Icon: -	Menu: **Project→Insert object**	Keyboard: **<Insert>**

Use this command to create a new object. The object type will depend on the tab selected in the *Object Organizer*.

Enter the name of the new object in the dialog box.

Note the following restrictions

- The organization unit names must not contain white spaces.
- Organization units and data types must not bear identical names.
- Global variable lists must not bear identical names.
- Actions within the same organization unit must not bear identical names.
- Visualizations must not bear identical names.

In all other cases, identical names are permitted. The actions of various different organization units can have identical names. Visualizations can have the same name as organization units.

Dialog for the creation of a new organization unit

The dialog must be fully completed. If the input is not in breach of the specified naming convention, press **OK** to create the new object in the Object Organizer and to display the associated input window.

The menu command **Edit→Insert** inserts the object from the clipboard. No dialog is displayed in this case. If the name is in breach of the naming convention, it will be extended with a continuous number lade_1, lade_2...

- Make sure that the object name is not already in use.
- If the object is an organization unit, the organization unit type (program, function or function block) and the language to be used for programming must also be selected.

Confirming the input will display the associated input window.

6.2.4.3 Rename object

Icon: -	Menu: **Project→Rename object**	Keyboard: **<Space bar>**

Use this command to rename the currently selected object or folder.

- Make sure that the object name has not been used before.
- If the object edit window is open, the rename will automatically change its title.

6.2.4.4 Convert object

Icon: -	Menu: **Project→Convert object**	Keyboard: -

This command can only be used for organization units. Use this command to convert organization units written in CFC, ST, FBD, LD and IL into IL, FBD or LD.

Note!

This command can only be used for organization units and requires a project compile for its execution.

1. Enter the name of the new organization unit in the dialog box. Make sure that the name of the organization unit is not used for another organization unit.
2. Select the language into which to convert.
3. Click **OK** to add the new organization unit to your organization unit list.

6.2.4.5 Copy object

Icon: -	Menu: **Project→Copy object**	Keyboard: -

Use this command to copy a selected object and save it under a new name.

Enter the name of the new object in the dialog box. Make sure that the object name has not been used before.

Click **OK** to copy the selected object.

- Use menu command **Edit→Copy** to copy the object to the clipboard. No dialog box is displayed in this case.

6.2.4.6 Edit object

Icon: -	Menu: **Project→Edit object**	Keyboard: **<Enter>**

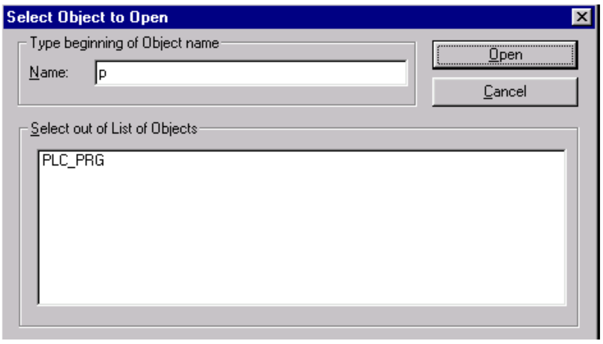
Use this command to load an object selected in the *Object Organizer* into the associated editor.

If a window with this object is already open, it will be brought to the front for editing.

Also open an object for editing by

- double-clicking the associated object or
- by clicking the *Object Organizer* and inserting the first letter of the object name into the *Object Organizer*.

Entering the first letter of the object name in the *Object Organizer* will open a dialog box displaying all objects of the set object type and starting with this letter.

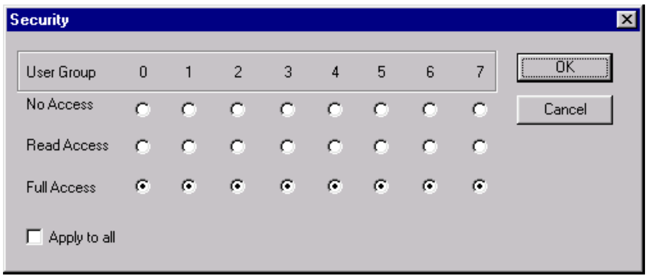


- Select the required object and click **Open** to load the object to its editing window.
- The object type Resources supports this option for global variables only.
- This function is especially helpful for projects comprising a multitude of objects.

6.2.4.7 Access rights

Icon: -	Menu: **Project→Object access rights**	Keyboard: -

Use this command to open the dialog box to assign access rights to the different user groups.



Members of user group 0 (administrators) can now assign access rights individually to each user group.

The following settings are possible:

- **No access**: No member of the user group can open this object.
- **Read access**: A member of the user group can open this object in read-only mode.
- **Full access**: A member of the user group can open and modify this object.

The settings refer either to the object currently selected in the *Object Organizer* or, if the check box **Apply to all** is activated, to all organization units, data types, visualizations and resources of the project.

As long as a password was set for user group 0, assignment to a user group happens through a password prompt when opening a project.

6.2.4.8 Properties

Icon: -	Menu: **Project→Object properties**	Keyboard: -

This command is available only if a global variable list has been selected in the Object Organizer. On generating a new global variable list, this dialog is opened with the menu command **Object→Insert**.The folder Global variables must be selected in the Object Organizer.

6.2.4.9 Open instance

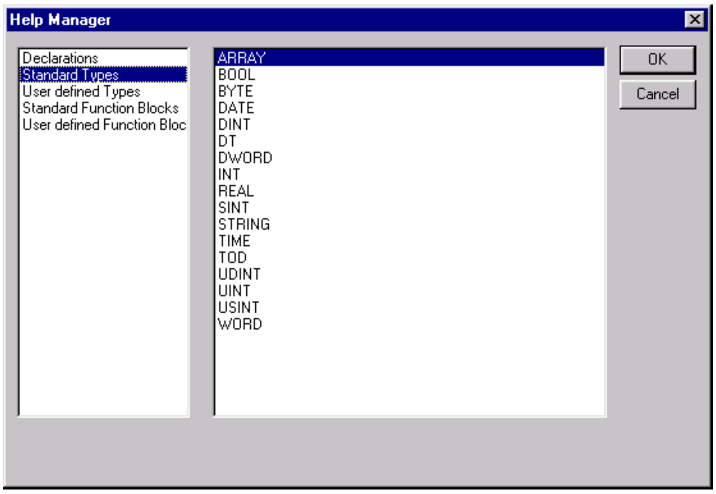
Icon: -	Menu: **Project→Open instance**	Keyboard: -

Use this command to open and display instances of function blocks in online mode. Double-clicking the function block in the Object Organizer opens a selection dialog listing the instances of the function block and the implementation. Select the required instance or implementation and click **OK** to display the list.

Note!

Before this command can be executed, first select the function block whose instance is to be opened in the *Object Organizer*!

Then use the *Help Manager* to select the required instance of this function block.



Tip!

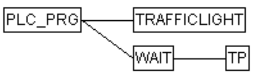
Instances can be opened after log-in only! (Project has been compiled correctly and transferred to the control with **Online→Log in**).

6.2.4.10 Output call tree

Icon: -	Menu: **Project→Output call up tree**	Keyboard: -

Use this command to open a window to display the call tree of the object selected in the *Object Organizer.*

Example: Call tree for object `PLC_PRG` of the traffic light system.



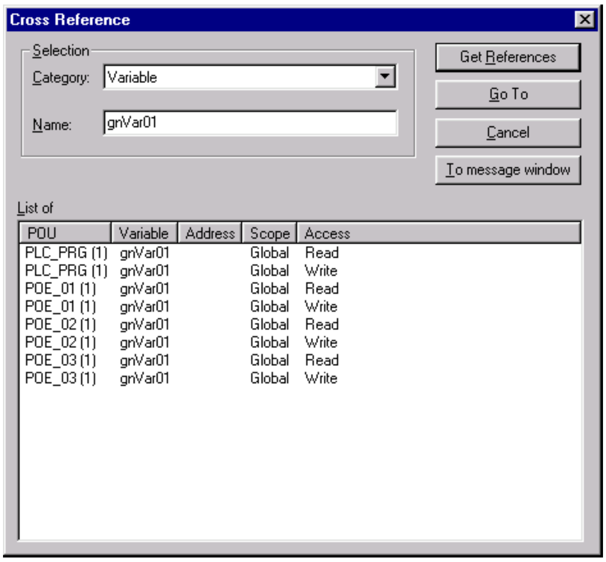
The command requires the project to be compiled. See **Project→Compile all**. (🕮 6-8)

- The call tree contains calls of organization units and references to applied data types.

6.2.4.11 Output cross reference list

Icon: -	Menu: **Project→Output cross reference list**	Keyboard: -

Use this command to open a dialog box to output all occurrences of variables, addresses or organization units.



The command requires the project to be compiled. See **Project→Compile all**

1. First select the category **Variable**, **Address** or **POU**.
2. Then enter the name of the required element.
   At *Name, enter* * to display all elements of the set category,
   or select the name of a variable and then execute menu command
   Project→Output cross reference list .The selected text then appears in the text field **Name**.
   Make sure to select the full variable name.
3. Click **Get references** for a list of all occurrences.

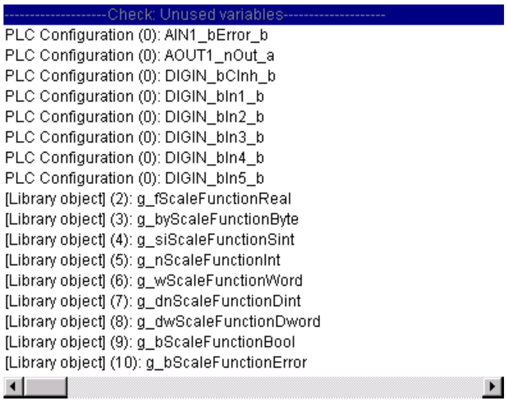
In addition to organization unit and line or network number, the specification will include the variable name and any linked addresses. The column *Scope* specifies the global or local variable. The column *Access* shows how to access the respective variable.

- Selecting a line in the cross reference list and clicking **Go to**, or double-clicking the line will display the organization unit at the associated location in its editor, allowing comfortable jumps to all occurrences.
- For smooth execution, click **To message window** to transfer the current cross reference list to the message window, and change from there to the organization unit in question.

6.2.4.12 Output unused variables

Icon: -	Menu: **Project→Output unused variables**	Keyboard: -

Use this command to output a list of all variables declared, but not used, in the project.


-------------------Check: Unused variables-------------------
PLC Configuration (0): AIN1_bError_b
PLC Configuration (0): AOUT1_nOut_a
PLC Configuration (0): DIGIN_bCInh_b
PLC Configuration (0): DIGIN_bIn1_b
PLC Configuration (0): DIGIN_bIn2_b
PLC Configuration (0): DIGIN_bIn3_b
PLC Configuration (0): DIGIN_bIn4_b
PLC Configuration (0): DIGIN_bIn5_b
[Library object] (2): g_fScaleFunctionReal
[Library object] (3): g_byScaleFunctionByte
[Library object] (4): g_siScaleFunctionSint
[Library object] (5): g_nScaleFunctionInt
[Library object] (6): g_wScaleFunctionWord
[Library object] (7): g_dnScaleFunctionDint
[Library object] (8): g_dwScaleFunctionDword
[Library object] (9): g_bScaleFunctionBool
[Library object] (10): g_bScaleFunctionError

The command requires the project to be compiled. See **Project→Compile all**

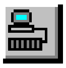
- Select a variable and click **Go to**, or double-click the variable, to go to the object in which the variable was declared.
- A message will be displayed if there are no unused variables within the project.

6.3 Working in online mode

The commands described in this chapter are available in the menu **Online** after log-in. Execution of some commands is dependent on the active editor and the selected automation system.

6.3.1 Commands in the “Online” menu

6.3.1.1 Log in

Icon: 	Menu: **Online→Log in**	Keyboard: **<Alt>+<F8>**

Use this command to combine the programming system with the control (or start the simulation program) and change into online mode.

- If the current project has not been compiled since it was opened or since the last change, it will be compiled now (in accordance with **Project→Compile all**). Compile errors will prevent the DDS from going into online mode.

Log-in error messages

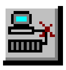
If the error message ”No connection with the control...” is displayed

- check that the automation system set in the automation system settings (Resources) matches the parameter set in **Online→Communication parameters**.
- check the connection between PC and automation system.
- After a correct log-in, the status line display will be **Online**.

If the error message ”The program has been changed! Do you want to load the new program?” appears, the current project in the editor does not match the program currently loaded into the control (or the launched simulation program).

- Monitoring and debugging are not possible in this case.
- Select **No** to log into the control. This will not load the project into the control.
- Select **Yes** to load the current project into the control.

6.3.1.2 Log out

Icon: 	Menu: **Online→Log out**	Keyboard: **<Ctrl>+<F8>**

Use this command to disconnect the link with the control or the simulation program and to change into offline mode.

6.3.1.3 Load

Icon: -	Menu: **Online→Download**	Keyboard: -

Use this command to download the program into the PLC.

- Note that a log-in will not launch a program download if the project in the DDS is identical to the project in the PLC.

6.3.1.4 Start

Icon:	Menu: **Online→Start**	Keyboard: **<F5>**

Use this command to start processing of the user program in the PLC or simulation.

The status line displays **RUNNING** after correct log-in and start.

The command can be executed under the following circumstances:

- After the user program was stopped in the control with the command **Online→Stop**.
- If the user program has hit a breakpoint.
- If the menu command **Online→Single cycle** was executed.

6.3.1.5 Stop

Icon:	Menu: **Online→Stop**	Keyboard: **<Shift>+<F8>**

Use this command to stop processing of the user program in the PLC or simulation between two cycles.

- If the program is stopped, the PLC sets quick stop (QSP).
- Use the command **Online→Start** to continue program processing.

6.3.1.6 Reset

Icon:	Menu: **Online→Reset**	Keyboard: -

Use this command to reset variables initialized with a certain value to this value.

- All other variables are reset to a standard value (e.g. integers to 0).
- The user will be asked to confirm the variable reset.

Differences between the command **Online→Reset** and mains disconnection/control power-off/-on:

- Code variables will only be reset to their initialization value in case of a **Reset**. In case of a mains disconnection, they will keep the value saved with C0003.
- From Servo PLC and Drive PLC operating system 6.0, RETAIN variables will not be re-initialized in case of a **Reset** or mains disconnection.
  In the previous version, they were re-initialized in case of a **Reset**.

Caution!

RETAIN variables will not be initialized from Servo PLC and Drive PLC operating system 6.0.

Use the command **Online→Start** to restart program processing.

6.3.1.7 Reset (cold)

Icon: -	Menu: **Online→Reset (cold)**	Keyboard: -

Use this command to reset all variables including the RETAIN variables to the initialization value. Only the persistent variables retain the value they had prior to the Reset (cold).

6.3.1.8 Reset (bootstrap)

Icon: -	Menu: **Online→Reset (bootstrap)**	Keyboard: -

Use this command to reset all variables, including RETAIN and PERSISTENT, to the initialization value. The user program in the PLC is cleared and the PLC is returned to its original status. From Servo PLC and Drive PLC operating system 6.0.

6.3.1.9 Breakpoint on/off

Icon:	Menu: **Online→Breakpoint on/off**	Keyboard: **<F9>**

Use this command to set a breakpoint at the current position in the active window.

- Breakpoints can also be set by clicking the line number field.
- If the current position is already occupied by a breakpoint, this breakpoint will be removed.
- A set breakpoint is identified with a line number/network number field or step with a light blue background colour.
- If a breakpoint is reached during program processing, the program stops and the associated field is displayed with a red background colour.
- Use the following commands to continue the program **Online→Start**, **Online→Single step in** or **Online→Single step over**.
- Breakpoints can also be set and removed with the menu command **Online→Breakpoint dialog**.

Warning!

If program processing is stopped as a consequence of a breakpoint, the behaviour defined under **Project→Exception handling** will take effect for the control.

The positions where a breakpoint can be set depend on the editor:

IL, ST

In the text editors (IL, ST), breakpoints will be set to the line with the cursor if this line is a breakpoint position (indicated by the dark grey line number field).

- Another option to set or remove a breakpoint is to click the line number field.

FBD, LD

In the FBD and LD editors, breakpoints will be set to the currently selected network.

- Another option to set or remove a breakpoint is to click the network number field.

SFC

In the SFC editor, the breakpoint will be set to the currently selected step.

- To set or remove a breakpoint, double-click while keeping the **<Shift>** key depressed.

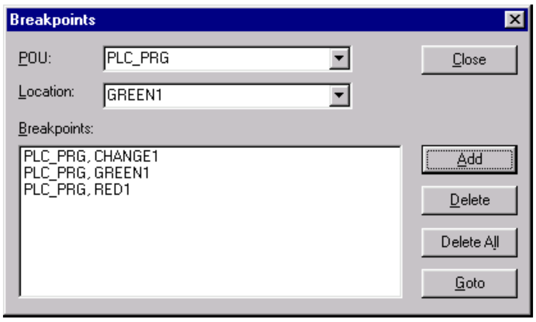
Note!

The setting of breakpoints will affect the operating system’s processing schedule.

6.3.1.10 Breakpoint dialog

Icon: -	Menu: **Online→Breakpoint dialog**	Keyboard: -

Use this command to open a dialog box to edit breakpoints in the entire project.



- The dialog box also shows all currently set breakpoints.

Setting a breakpoint

1. In the combination box **POU**, select the organization unit in which the breakpoint is to be set.
2. In the combination box **Location**, select the line or the network in which the breakpoint is to be set.
3. Click **Add** to set the breakpoint at the required position. The breakpoint will be added to the list.

Deleting a breakpoint

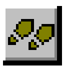
Select the breakpoint to be deleted in the list of set breakpoints and click **Delete**.

- Click **Delete all** to delete all breakpoints.

Going to breakpoint position

To reach the location within the editor where a specific breakpoint was set, select the breakpoint in the list of set breakpoints and click **Go to**.

6.3.1.11 Single step over

Icon: 	Menu: **Online→Single step over**	Keyboard: **<F10>**

Use this command to execute a single step. In the case of organization unit calls, the program will only be stopped after the step has been processed.

- SFC processes complete actions.

If the current instruction is a function or function block call, the function or function block will be executed completely.

Use the command **Online→Single step in** to go to the first instruction of a called function or function block.

On reaching the last instruction, the program continues with the next instruction of the calling organization unit.

6.3.1.12 Single step in

Icon: -	Menu: **Online→Single step in**	Keyboard: **<F8>**

Use this command to process a single step. In the case of organization unit calls, the program stops before the first instruction of the organization unit is executed.

- If appropriate, the process will switch to a called organization unit.

If the current position is a function or function block call, the command is passed on to the first instruction of the called organization unit.

In all other situations, the command behaves exactly like the command **Online→Single step over**.

6.3.1.13 Single cycle

Icon: -	Menu: **Online→Single cycle**	Keyboard: **<Ctrl>+<F5>**

Use this command to execute a single control cycle and stop after this cycle.

- **Online→Single cycle** works for cyclical tasks only and will not consider the EVENT/INTERVAL tasks.
- **Online→Single cycle** can be repeated continuously to proceed in single cycles.
- Single cycle ends if the menu command **Online→Start** is executed.

6.3.1.14 Write values

Icon: -	Menu: **Online→Write values**	Keyboard: **<Ctrl>+<F7>**

Use this command to change the value of single-element variables.

Double-click the line in which the variable is declared, or select the line and press **<Enter>**.

- This will display a dialog box to specify a new value for the variable. In the case of Boolean variables, the value will be toggled without dialog box display.

The new value (now light blue) will not be written to the control immediately.

- Change as many variables as necessary and transfer them to the PLC in one go (cycle-consistent).

1. Defining the values
   – In the case of non-Boolean variables, double-click the line in which the variable is declared to open a dialog box **Write variable 'Counter'**(counter as example) to enter the value to be written to the variable.
   – In the case of Boolean variables, double-click the line in which the variable is declared to toggle the value (between **TRUE, FALSE** and no new value) without a dialog display.

The new value to be written will be displayed in angular brackets and light blue colour behind the old declaration value.

Tip!

The following exception applies for the display of values to be written.
FBD and LD editors display a value without angular brackets and in turquoise colour next to the variable name.

- Value definition may be performed for any number of variables.
- The values may be entered for writing, modified and deleted.
- The values to be written will be stored in a write list (watch list) until written or deleted.

2. Writing values
   – Menu command **Online→Write values**
   – Dialog box *Edit write list and force list* button **Write values**

Execution of **Write values** will write all values in the write list once-only to the associated variables in the control at the beginning of the cycle, thus deleting the variables from the write list.

Tip!

In SFC, the individual values that make up a transition expression cannot be modified with **Write values**.

Monitoring displays the overall value of the expression, not the values of the individual variables.
Example:
a AND b will only then be displayed as TRUE if both variables are TRUE.

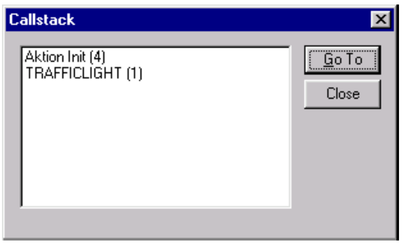
In FBD, only the first variable of an expression, that may be used as input of a function block, for example, becomes visible (monitor). **Write values** is possible for this variable only.

Write values writes changed values to the control once-only where they can be overwritten again immediately.

6.3.1.15 Call hierarchy

Icon: -	Menu: **Online→Show Call Stack**	Keyboard: -

If simulation stops at a breakpoint, use this command to open a dialog box that lists the organization units currently in the call stack.



- The first organization unit is always `PLC_PRG` as this is where processing starts.
- The last organization unit is always the organization unit that is currently being processed.

Select an organization unit and click **Go to** to load the selected organization unit into a window and to display the line or network that is currently processed.

6.3.1.16 Simulation

Icon: -	Menu: **Online→Simulation**	Keyboard: -

Selection of **Simulation** puts a tick ✓ in front of the menu item.

In simulation mode, the user program will run under Windows on the same PC. Simulation tests the project. Communication between PC and simulation uses the Windows Message Mechanism.

If the program is not in simulation mode, it will run on the control. Communication between PC and control uses a gateway. The status of this flag is stored with the project.

Restrictions for simulation

If all tasks are to be considered during simulation, adapt the interval times accordingly.
The following projects are restricted during simulation or cannot be simulated.

- Lenze function blocks
- System organization units

6.3.1.17 Communication parameters

Icon: -	Menu: **Online→Communication parameters**	Keyboard: -

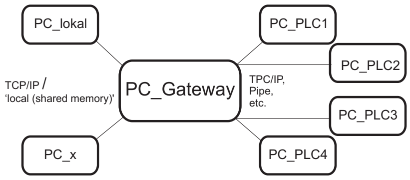
Use this command to create and manage communication channels to the automation system.

Note!

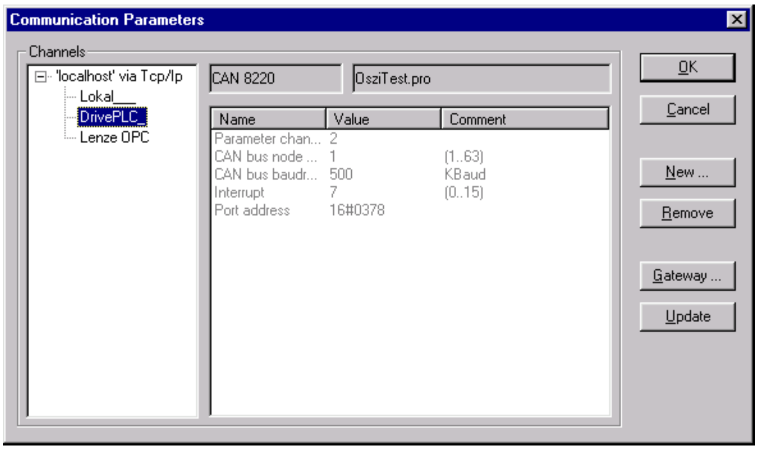
Use of the OPC or DDE server requires the same communication parameters to be set in that server's configuration.

The following channels to the automation system are currently available for practical use:

- **Local gateway**
- **Remote gateway**
  Via a TCP/IP network to a remote gateway PC with parallel port and dongle.



The dialog box *Communication parameters* is divided into four panes:



1. Channels

This is where the communication channels from the local host are displayed and those to be edited are selected.

2. Communication driver display

The currently loaded communication driver (e. g. “CAN 8220 | JumpingLEDs.pro”).

3. Communication parameters

The parameters set for the currently loaded communication driver.

4. Buttons

OK	Quit and accept parameters
Cancel	Quit and reject parameters
New...	Create a new communication channel, via the parallel port/system bus dongle, for example
Remove	Remove a channel selected in pane **Channels**
Gateway	Create a new communication channel to a remote gateway PC
Update	Check parameters or update the display

Creating a communication channel via the system bus dongle

The most commonly used communication option is via the system bus dongle connected to a local PC via the parallel port.

Two parameters must be known to establish a connection to a certain automation system (e. g. **9300 Servo PLC**) within a CAN bus network:

- The device address on the bus (CAN bus node address). The device address is stored in code C0350 of the automation system and must match the setting of the communication channel.
- The baud rate set on the bus (CAN bus baud rate). The device address is stored in code C0351 of the automation system and must match the setting of the communication channel.

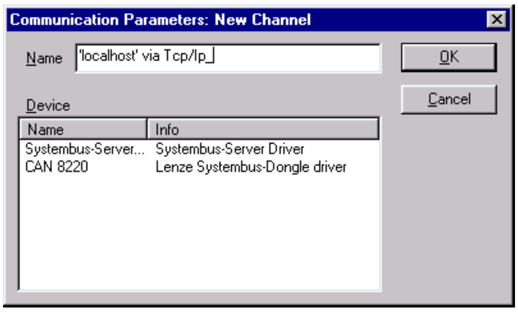
Note!
The Lenze default setting for DDS and automation system is a baud rate of 500 KBaud.

Creating a channel with default parameters

Select *Communication parameters* and click **localhost→Lenze standard** and then **OK**.

Creating a communication channel with the Lenze CAN driver

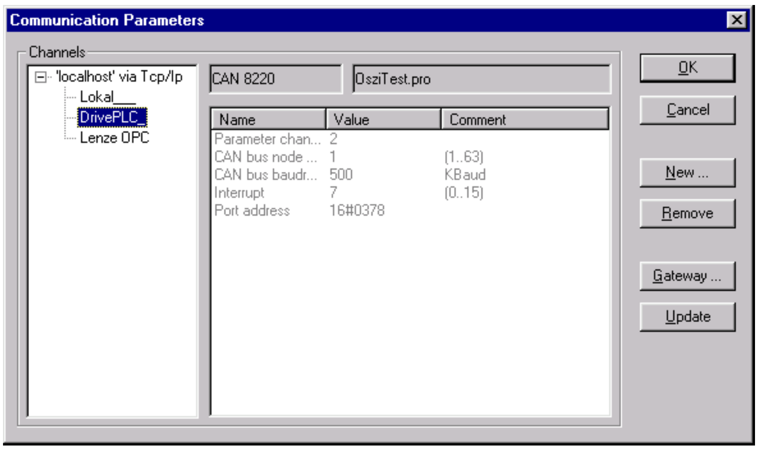
1. Click **New** to configure a new localhost channel.
2. Select *Communication parameters: New channel* and click **CAN 8220**:



3. Click **OK**.
4. Select the new channel and enter the defined /required parameters in **Communication parameters** by clicking the relevant entry and select the parameters using the arrow keys.
5. Accept the settings with **OK**.
   (This parameterizes and starts the communication driver GATEWAY.EXE.)

Creating a communication channel with the OPC system bus driver

1. Click **New** to configure a new channel.
2. Select *Communication parameters: New channel*, list field **Device** and click **Systembus Server Driver**.
3. Click **OK**.



4. Use the entry **Hardware Number** to select a specific port. If 0 is entered, the standard port will be used.
   Use the communication tool **System bus configurator** to determine:
   – how many active ports are available
   – the individual port numbers
   – the standard port

5. Use the entry **Can bus node address** to select a device address.
   The device address is stored in code C0530 of the automation system and must match the device address of the communication channel.
6. Accept the settings with **OK**. This parameterizes and starts the communication driver GATEWAY.EXE.

Creating a communication channel via a TCP/IP network to a remote gateway PC

Access to a remote PC (remote gateway PC) with system bus dongle is possible from the DDS via a TCP/IP network.

Thus all functions under a direct CAN bus access (such as program download, monitoring, etc.) can be executed via the network.

For this purpose, the communication channel from the gateway PC to the automation system must be set up properly at the gateway PC, and the communication driver GATEWAY.EXE must run on the remote gateway PC (see “Creating a communication channel via the system bus dongle”).

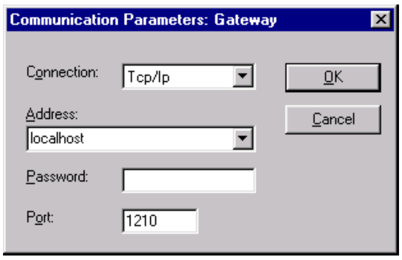
- A remote change of the communication parameters on the gateway PC via the TCP/IP network is currently not possible.
- The IP address of the remote PC in the network must be known to create a connection to a gateway PC.

Finding out the IP address of the gateway PC

Contact your network administrator for the IP address (or open the program “IPCONFIG” in a DOS window on the gateway PC).

Creating a channel to the gateway PC via a TCP/IP network

1. Select *Communication parameters* and click **local**.
2. Click **Gateway** to open the dialog box *Communication parameters: Gateway*.



3. Enter the IP address of the gateway PC and click **OK**.

Channels displays the IP address of the gateway PC and **Communication parameters** the parameters set on the PC.

- If “(Not connected)” is displayed behind the IP address, the communication driver GATEWAY.EXE is not running on the gateway PC. Start the driver from the DDS on the gateway PC.

Removing a communication channel via a TCP/IP network to a remote gateway PC

Proceed as follows to remove a connection to a remote gateway PC and return to the local gateway:

1. Select the IP address in *Communication parameters* under **Communication parameters**.
2. Click **Gateway** to open the dialog box *Communication parameters: Gateway*.
3. Use the input field **Address** to enter”localhost” and click **OK**.

Unsuccessful communication setup

An unsuccessful attempt to set up communication with the gateway server on a different PC. The following aspects must be met for correct communication setup.

- The tri-colour icon in the lower menu bar shows the active gateway server.
- Was the correct IP address entered in the dialog box *Communication parameters: Gateway*?
- The local TCP/IP connection must work.

6.3.1.18 Controller enable

Icon: -	Menu: **Online→Controller enable**	Keyboard: -

Use this command to enable the controller.

The menu item will be deactivated for automation systems without controller inhibit.

- In GDC, this function corresponds to the key **Start**.

Warning!

Do not use the commands **Controller enable**/**Controller inhibit** for an emergency stop via the PC as these commands reach the controller with a delay.

In the DDS, these commands are added to the end of a message queue so that they will reach the controller with a delay of several seconds in a worst-case scenario.

6.3.1.19 Controller inhibit

Icon: -	Menu: **Online→Controller inhibit**	Keyboard: -

Use this command to inhibit the controller.

The menu item will be deactivated for automation systems without controller inhibit.

- In GDC, this function corresponds to the key ”Stop”.

6.4 Log

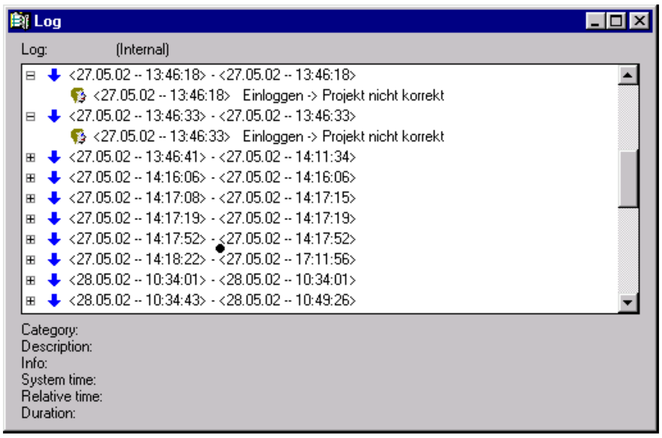
The log records the actions during an online session in chronological sequence. For this purpose, a binary log (*.log) is created for each project. The user can save extracts from the respective project log in an external log.

6.4.1 Log characteristics

6.4.1.1 Log window

The log window can be opened in both offline and online modes. In online mode, it can be used as direct monitor.

Icon: -	Menu: **Window→Log**	Keyboard: -



Information on the log window

- In the title bar appears the file name of the currently displayed log.Should this be the log of the current project, the upper section of the dialog box displays [Internal].
- The entries are shown in the window. The latest entry is attached at the bottom.
- The display includes only the actions of those categories that are activated in menu **Project→Options** category *Log* group field **Filter** with a (✓).
- Below the log window appears the information available for the selected entry.
- Under **Project→Options** category *Log*, the log can be activated or deactivated with the check box **Activate logging**.

Category

The log entry consists of four categories.

	User action The user performed an online action.
	Internal action An action was performed in the online shift (e. g., Delete Buffers or Init Debugging).
	Status change The runtime system status has changed (for example, from Running to Break if a breakpoint was reached).
	Exception An exception has occurred (a communication error, for example).

Description

User actions are named after their associated menu commands. All other actions are in English and named based on the associated `OnlineXXX()` function.

Information

This field describes errors that occur during an action. The field remains blank if no errors occur.

System time

The current system time on action start.

Relative time

The relative time at online session start.

Duration

The duration of the action in milliseconds.

6.4.1.2 Log menu

If the input focus is on the log window, the menu command **Log** is shown in the menu bar instead of **Insert**. **Extras** remains preserved but blank.

6.4.1.3 Load

Icon: -	Menu: **Log →Load**	Keyboard: -

An external log (*.log) can be loaded and displayed via the standard Windows file opening dialog.

- The log within the project will not be overwritten by the command.
- The loaded version will be replaced with the project log if
  – the log window is closed and re-opened.
  – a new online session is started.

6.4.1.4 Save

Icon: -	Menu: **Log→Save**	Keyboard: -

This command can be selected only if the project log is displayed and can be used to save a project log extract into an external file. The sessions must be selected to be saved.

Pressing **OK** returns the standard Windows file save dialog.

6.4.1.5 Display project log

Icon: -	Menu: **Log→Display project log**	Keyboard: -

This command can be selected only if an external log is currently displayed and switches the display back to the project log.

6.4.1.6 Saving the project log

The project log is automatically saved in a binary file `projectname.log` independently of a log save to an external file.

Use menu command **Project→Options** category *Log* to specify a save path. If no path is specified, the log will be saved in the same directory that already stores the project.

Use menu command **Project→Options** category *Log* to specify the number of online sessions via text field **Maximum project log size**. If the number is exceeded, the earlier ones will be removed in favour of the later ones in accordance with the first-in-first-out principle.

7 Editors

7.1 General edit functions

The commands described in this chapter are available in all editors under menu **Edit** and in some cases also via the shortcut menu in the *Object Organizer*.

Printer borders

Menu command **Project→Options,** category *Desktop* includes the check box **Printer borders**. This feature allows the printable area of the individual editors to be outlined in red, subject to the specifications of the set printer and the template size selected in the menu command **File→Documentation setup** .

Default settings will apply where no printer or documentation size is set (default.DFR and standard printer).

The horizontal printer borders are drawn as if, in the dialog box *Documentation Setup,* the check box **New page for each object** or **New page for each subobject** were selected. The bottom margin is not displayed.

Tip!

Set the zoom factor to 100 % to ensure exact printer border display.

7.1.1 Commands in the "Edit" menu

7.1.1.1 Undo

Icon: -	Menu: **Edit →Undo**	Keyboard: **<Ctrl>+<Z>**

Use this command to undo the last action in the currently open editor window or in the *Object Organizer* .

All actions executed since the window was opened can be undone by repeating execution of this command.

- This applies to all actions in the editors for organization units, data types, visualizations and global variables and in the Object Organizer.

Use **Edit→Redo** to redo an undone action.

Tip!

The commands **Undo** and **Redo** always act on the currently open window.

Each window has its own action list. Activate the associated window to undo actions in several windows.

Undo's or redo's in the *Object Organizer* require the Object Organizer to be the active window.

7.1.1.2 Redo

Icon: -	Menu: **Edit →Redo**	Keyboard: **<Ctrl>+<Y>**

Use this command to redo an action undone with **Edit→Undo** in the currently open editor window or in the *Object Organizer.*

- The command **Redo** can be executed as often as the command **Undo** before.

7.1.1.3 Cut

Icon:	Menu: **Edit →Cut**	Keyboard: **<Ctrl>+<X>** **<Umschalt>+<Del>**

Use this command to remove the current selection from the editor and save it to the clipboard.

- In the case of the *Object Organizer* , this applies analogously to selected objects, although some objects cannot be cut (such as the PLC configuration, for example).

Note!

Note that not all editors support the cut function, and that the functionality may be limited in some editors.

The selection format depends on the editor:

- In text editors (IL, ST, declaration), the selection is a sequence of characters.
- In the FBD, LD and CFC editors, the selection is a number of networks identified by a dotted rectangle in the network number field or a box with all lines, boxes and operands.
- In the SFC editor, the selection is part of a step sequence surrounded by a dotted rectangle.

The contents of the clipboard can be inserted by using the command **Edit→Insert**.

- The SFC editor also allows use of the commands **Extras→Insert parallel branch (right)** or **Extras→Insert after**.

7.1.1.4 Copy

Icon:	Menu: **Edit →Copy**	Keyboard: **<Ctrl>+<C>** **<Ctrl>+<Insert>**

Use this command to copy the current selection from the editor to the clipboard. The contents of the editor window will not be changed.

- In the case of the *Object Organizer* , this applies analogously for selected objects, although some objects cannot be copied (such as the PLC configuration, for example).

Tip!

Note that not all editors support the copy function, and that the functionality may be limited in some editors.

The selection format depends on the editor:

- In text editors (IL, ST, declaration), the selection is a sequence of characters.
- In the FBD, LD and CFC editors, the selection is a number of networks identified by a dotted rectangle in the network number field or a box with all lines, boxes and operands.
- In the SFC editor, the selection is part of a step sequence surrounded by a dotted rectangle.

The contents of the clipboard can be inserted by using the command **Edit→Insert**.

- The SFC editor also allows use of the commands **Extras→Insert parallel branch (right)** or **Extras →Insert after**.

7.1.1.5 Insert

Icon:		Menu:	**Edit →Insert**	Keyboard:	**<Ctrl>+<V>** **<Umschalt>+<Insert>**

Use this command to insert the contents of the clipboard at the current position in the editor window.

- With graphically oriented editors, this command can be used only if insertion produces a correct structure.
- In the case of the *Object Organizer*, the object is inserted from the clipboard.

Tip!

Note that not all editors support the insert function, and that the functionality may be limited in some editors.

Clipboard contents may be inserted at different locations, insertion being dependent on the associated editor.

- In the case of text editors (IL, ST, declaration), the current location is the position of the flashing cursor (a small vertical line that can be positioned with the mouse).
- In the case of FBD, LD and CFC editors, the current position is the first network with a dotted rectangle in the network number range. The contents of the clipboard are inserted in front of this network. Any part of a structure, that was copied, will be inserted in front of the selected element.
- With the SFC editor, the current position is determined by the selection surrounded by a dotted rectangle. Dependent on the selection and the clipboard contents, the clipboard contents will be inserted in front of this selection or in a new branch (parallel or alternative) to the left of the selection.
- The SFC editor also allows use of the commands **Extras→Insert parallel branch (right)** or **Extras→Insert after**.

7.1.1.6 Delete

Icon:	-	Menu:	**Edit →Delete**	Keyboard:	**<Del>**

Use this command to delete the selected range from the editor window. The contents of the clipboard will not be changed.

- In the case of the *Object Organizer* , this applies analogously to selected objects, although some objects can not be deleted (such as the PLC configuration, for example).

The selection format depends on the editor:

- In text editors (IL, ST, declaration), the selection is a sequence of characters.
- In the FBD, LD and CFC editors, the selection is a number of networks identified by a dotted rectangle in the network number field.
- In the SFC editor, the selection is part of a step sequence surrounded by a dotted rectangle.
- In the Library Manager, the selection is the currently selected library name.

7.1.1.7 Find

Icon:	Menu: **Edit→Find**	Keyboard: **<Ctrl>+<F>**

Use this command to find a character sequence in the current editor window.

Selection of the command opens the dialog box *Find*.

- The dialog box *Find* remains open until **Cancel** is clicked.

Find what

Use the input field **Find what** to enter the character sequence to be found.

Match whole word only

Select whether the text to be found is a whole word or also part of a word.

Match case

Select whether the search is to be case-sensitive or not.

Direction

Select whether the search is to be up or down from the current cursor position.

Start search

Click **Find next** to start the search.

Search starts at the selected position and is performed in the selected direction.

- Any found text occurrence will be highlighted.
- Unsuccessful searches will be notified.

Tip!

The search can be repeated by clicking **Find next** again and will stop on reaching the beginning or end of the editor window contents.

Note that the text found may be hidden behind the dialog box *Find* .

7.1.1.8 Find next

Icon:	Menu: **Edit →Find next**	Keyboard: **<F3>**

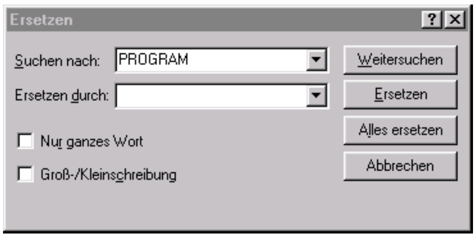
Use this command to search the text using the same parameters as before with the command **Edit→Find**.

7.1.1.9 Replace

Icon: -	Menu: **Edit →Replace**	Keyboard: **<Ctrl>+<H>**

Use this command to find a character sequence in the current editor window and replace it with another sequence.

Selection of the command opens the dialog box *Replace*.



- The dialog box *Replace* remains open until **Cancel** is clicked.

Find what

Use the input field **Find what** to enter the character sequence to be found.

Replace with

Use the input field **Replace with** to enter the character sequence which is to replace the text to be found.

Match whole word only

Select whether the text to be found is a whole word or also part of a word.

Match case

Select whether the search is to be case-sensitive or not.

Start search

Click **Find next** to start the search.

The search starts at the current position.

- Any found text occurrence will be highlighted.
- Unsuccessful searches will be notified.

Replace

Click **Replace** to replace the currently selected text with the text in **Replace with**.

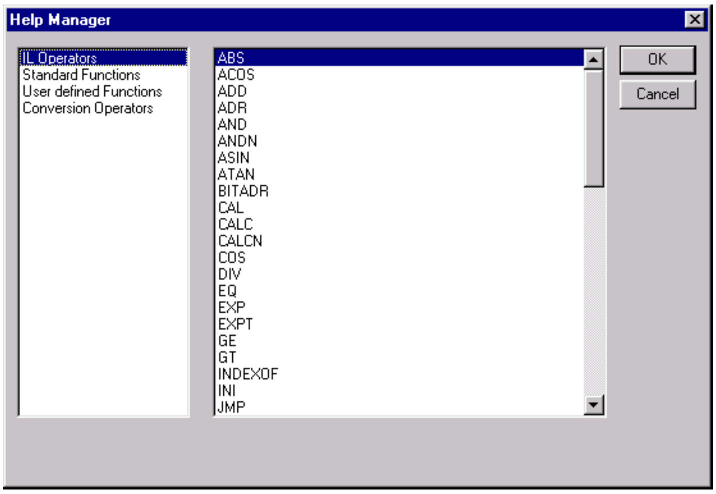
Replace all

Click **Replace all** to replace all text occurrences found behind the current location with the text in **Replace with**.

7.1.1.10 Help Manager

Icon:	-	Menu:	**Edit→Help Manager**	Keyboard:	**<F2>**

Use this command to open the dialog box *Help Manager* for a display of possible inputs at the current cursor position in the editor window.



1. Select the input category from the column on the left.
2. Select the required entry in the column on the right.
3. Click **OK** to confirm the selection.

The selection will be inserted at the current cursor position.

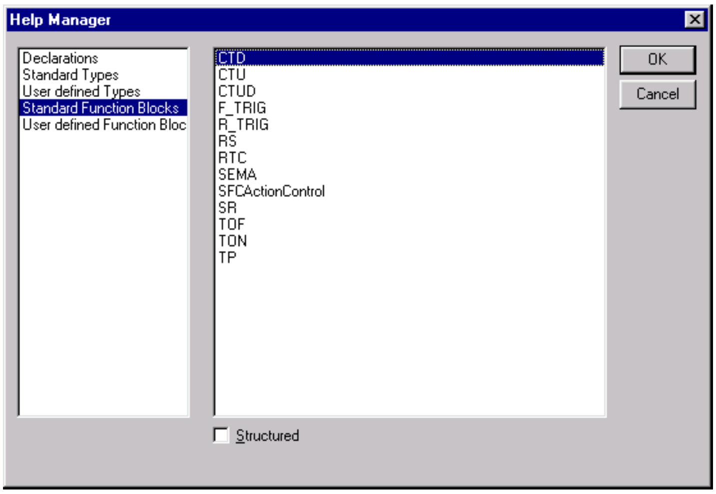
- The Help Manager is context-sensitive, i.e. the categories available depend on the current editor window and the current cursor position.
- With arguments
- In the case of this option, the arguments to be transferred are also specified on insertion of the selected element.

Examples:

Selection of function block fu1 with defined input variable var_in:
fu1(var_in:=);
Insertion of function func1 that requires var1 and var2 as transfer parameters:
func1(var1, var2);

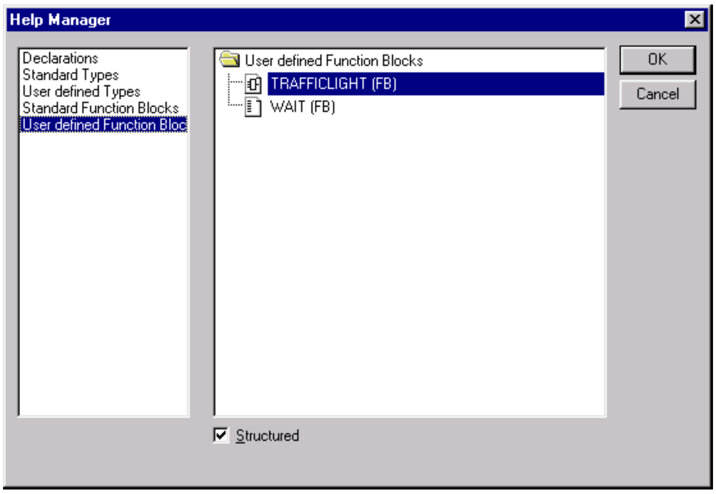
Toggling between structured and non-structured representation of the available elements is possible on principle by activating/deactivating the option **Structured**.

Unstructured diagram



The organization units, variables or data types in each category are sorted in linear and alphabetical sequence. Some positions (e. g. Watch list) require multi-level variable names. The dialog box Help Manager then displays a list of all organization units and a single item for global variables. Organization unit names are completed with a period. A list of associated variables is displayed once an organization module has been selected. This list can be opened further if there are instances and data types. Click **OK** to accept the last-selected variable.

Structured diagram



Organization units, variables or data types are put into a hierarchical sequence. This is possible for

- Standard programs
- Standard functions
- Standard function blocks
- Standard types
- Defined programs
- Defined functions
- Defined function blocks
- Global variables
- Local variables
- Defined types
- Watch variables.

Visual and hierarchical representation is in unison with that of the Object Organizer. Any elements within libraries are inserted alphabetically at the top, and the respective hierarchy is displayed as in the Library Manager.

The input and output variables of function blocks that are declared as local or global variables, are located in the form of a list underneath the instance name in the Local variable or Global variable category.

- Inst_TP.ET
- Inst_TP.IN

Inst_TP can be expanded like an Explorer directory.

With arguments

If the check box is selected, the instance name and the input parameters of the function block will be inserted for the ST and IL text languages and in task configuration.
Selection of Inst (DeclarationInst:TON;) inserts
Inst(IN:=, PT:=, Q=>, ET=>);.

:= Assign function block inputs

=> Assign function block outputs

If the check box is not selected, only the instance name will be inserted. In general, only the instance name will be inserted in the case of graphic languages or in the Watch window.

Components of structures are represented analogously to the function block instances.

Enumerations list the individual values underneath the respective type, adhering to the following sequence:
Enumerations from libraries, from data types, local enumerations from organization units.

Note!
Some entries (e. g. global variables) will only be updated in the Help Manager after a compile.

7.1.1.11 Next fault

Icon: -	Menu: **Edit→Next fault**	Keyboard: **<F4>**

Use this command to display the next error after a project compiled with errors.

- The associated editor window is activated and the error location highlighted.
- The associated error message will be displayed in the message window at the same time.
- Warnings may be ignored on single-stepping with **F4**.
  Project→Options category *Desktop* check box **F4 ignores warnings**.

7.1.1.12 Previous fault

Icon: -	Menu: **Edit→Previous fault**	Keyboard: **<Umschalt>+<F4>**

Use this command to display the previous error after a project compiled with errors.

- The associated editor window is activated and the error location highlighted.
- The associated error message will be displayed in the message window at the same time.
- Warnings may be ignored on single-stepping with **<Umschalt>+<F4>**.
  Project→Options category *Desktop* check box **F4 ignores warnings**.

7.1.1.13 Macros

Icon: -	Menu: **Edit→Macros**	Keyboard: -

This menu item lists all macros agreed for the current project. New macros can be created under **Project→Options** category *Macros*. Selection of an executable macro opens dialog box *Process macro*. Macro name and current command line are displayed. Use **Cancel** to stop the macro. The current command line will still be processed.

The message window will show a message that will be logged in online mode.
Macro canceled.

Macros may be processed both online and offline. Only the commands available in the respective mode will be executed.

7.2 Declaration editor

The declaration editor is used to declare variables of organization units and global variables, for data type declaration and in the Watch and Receipt Manager. It offers Windows and IntelliMouse functionalities, but requires the associated driver to do so.

The overtype mode is displayed in the status bar with **OVR**. Press **<Insert>** to toggle between overwrite and insert modes.

PLC_PRG (PRG-SFC)

```
PROGRAM PLC_PRG
VAR
    LIGHT1:TRAFFICLIGHT;
    LIGHT2:TRAFFICLIGHT;
    WAIT1:WAIT;
    WAIT: BOOL;
    t: BOOL;
    COUNTER:INT;
    LIGHTOFF: BOOL;
    LIGHT: BOOL;
    OK: BOOL;
END_VAR
```

- Variable declaration is supported by the use of various colours. Keywords are written in blue letters.
- In all editors for organization units, a horizontal screen divider separates declaration part from body on screen. This divider can be moved as required by keeping the left mouse key depressed.

Tip!

The most essential declaration editor commands are also available in the shortcut menu (right mouse key or **<Umschalt>+<F10>**).

Declarations as tables

Instead of the declaration editor, use menu item **Project→Options**, category *Editor* to edit variables as a table with the help of selecting check box **Declarations as tables**. (📖 7-18)

VAR | VAR_INPUT | VAR_OUTPUT | VAR_IN_OUT | CONSTANT | RETAIN | INFO

	Name	Address	Type	Initial	Comment
0001	TP2		TP		
0002	TP1		TP		
0003	btogg		BOOL		
0004	bNOTtogg		BOOL		
0005	bFillIn		BOOL		

- This table is arranged as a card index box with tab cards for input variables (VAR_INPUT), output variables VAR_OUTPUT, local variables VAR and input / output variables VAR_INPUT.
- Fields for name, address, type, initial value and comment are available for each variable.

7.2.1 Declaration part

The declaration part of an organization unit declares all variables locally.

These may be

- input variables,
- output variables,
- input / output variables,
- local variables,
- retentive variables,
- constants
- and retentive constants.

The declaration syntax is based on the IEC 61131-3 standard.

7.2.1.1 Declaration keywords

Icon: -	Menu: **Insert→Declaration keywords**	Keyboard: -

Use this command to open a list of all keywords available for use in the declaration part of an organization unit.

- The keyword will be inserted at the current cursor position once it has been selected and confirmed.
- The list will also be displayed when calling the Help Manager and selecting the category *Declarations*.

7.2.2 Input variables

Between the keywords **VAR_INPUT** and **END_VAR**, all variables are declared that are used as input variables for an organization unit.

- The values of these variables can be transferred from the calling unit.

Example:

```
VAR_INPUT
 in1:INT; (* 1. input variable *)
END_VAR
```

Input variables can be used to transfer data from the calling to the called organization unit.

7.2.3 Output variables

Between the keywords **VAR_OUTPUT** and **END_VAR**, all variables are declared that are used as output variables for an organization unit.

- The values of these variables are returned to the calling organization unit for further use.

Example:

```
VAR_OUTPUT
 out1:INT; (* 1. output variable *)
END_VAR
```

7.2.4 Input / output variables

Between the keywords **VAR_IN_OUT** and **END_VAR**, all variables are declared that are used as input and output variables for an organization unit.

Note!

In the case of these variables, the value of the transferred variables is changed directly ("Transfer as pointer", call-by-reference). Therefore, the input value for these variables must not be a constant. For this reason, **VAR_IN_OUT** variables of a function block can not be read directly from outside via *Function block instance*, *Input / output variable*.

Example:

```
VAR_IN_OUT
 inout1:INT; (* 1. input / output variable *)
END_VAR
```

7.2.5 Local variables

Between the keywords **VAR** and **END_VAR**, all local variables of an organization unit are declared.

- Local variables have no connection to the outside, i. e., they cannot be written from outside.

Example:

```
VAR
 loc1:INT; (* 1. local variable *)
END_VAR
```

7.2.6 Retentive variables

Retentive variables may retain their value beyond the standard program runtime. Retentive variables include Retain variables and persistent variables.

Retain variables

All retain variables of an organization unit are declared between the keywords **VAR Retain** and **END_VAR**.

- Retain variables retain their values after a control disconnect or after a reset. When the program is restarted, the stored values are used for further processing.
- In two cases the retain variables are reset to their initialization values.
  – With a program download.
  – In online mode with the menu commands Online Reset (cold) and Online Reset (bootstrap).

Persistent variables

Persistent variables are stored in the persistent memory and retain their values. The persistent memory can only be cleared in online mode via the menu command Online Reset (bootstrap).

The persistent memory can be accessed via the system organization unit **Var_Persistent**.

In the Object Organizer, tab Resources you can open the PLC configuration. Use the menu command Insert Add subelement **Var_Persistent...** to add the system organization unit as a subelement.

Application example

An operating hour meter that is to continue counting after a mains failure.

- All other variables will be re-initialized either with the standard initial values (0 or FALSE) or with the defined initial values.

Example:

```
VAR RETAIN
 rem1:INT; (* 1. retentive variable *)
END_VAR
```

7.2.7 Constants, typed literals

Between the keywords **VAR CONSTANT** and **END_VAR**, all constants are declared.

- Constants can be declared locally or globally.

Syntax:

```
VAR CONSTANT
 <Identifier>:<Type> := <Initialization>;
END_VAR
```

Example:

```
VAR CONSTANT
 con1:INT:=12; (* 1. constant *)
END_VAR
```

For a list of permitted constants refer chapter on Operands. (🕮 13-1)

7.2.8 Retentive constants

Between the keywords **VAR CONSTANT RETAIN** and **END_VAR**, all retentive constants are declared.

- Retentive constants can be declared locally or globally.

Syntax:

```
VAR CONSTANT RETAIN
 <Identifier>:<Type> := <Initialization>;
END_VAR
```

Example:

```
VAR CONSTANT RETAIN
 Acceleration: DINT:=10000; (* acceleration time *)
END_VAR
```

7.2.9 Keywords

- All editors require keywords to be written in capitals.
- Keywords must not be used as variable names.

7.2.10 Identifiers

Note!
Only the first 32 characters are of any significance!

Identifiers are a sequence of letters, digits and underscores starting with a letter or an underscore.

Variable identifiers must not:

- contain white spaces and umlauts,
- be declared twice
- be identical to keywords.

Furthermore:

- Case sensitivity is **not** an option for variables.
  (Example: `VAR1`, `Var1` and `var1` are not different variables)
- Underscores in an identifier are significant.
  (Example: `A_BCD` and `AB_CD` are interpreted as different identifiers.)
- Multiple successive underscores at the beginning of or within an identifier are **not** allowed.

7.2.11 Variable declaration

Syntax:

```
<Identifier> {AT <Address>}:<Type> {:= <Initialization>};
```

The parts in curly brackets {} are optional.

All variable declarations and data type elements may contain initializations.

- Initializations are effected with assignment operator ":=".
- Initializations are constants for variables of elementary types.
- The default initialization for all declarations is 0 or FALSE.

Example:

```
var1: INT:=12; (* integer variable with initial value 12*)
```

- If the variable is to be directly linked to a certain address, the variable must be declared with the keyword **AT**.
- Use the short form mode for quick entry of declarations.
- In function blocks, variables may also be specified with incomplete address details. Use of such variables in local instances requires respective entries in the variable configuration.

Note the automatic declaration option.

Tip!
Observe the information given in chapter IEC 61131-3 Operands for variable identifiers. (📖 13-4)

7.2.11.1 Types for variable declaration

Icon: -	Menu: **Insert→Types**	Keyboard: -

Use this command to display a selection of types available for variable declaration.

- Use of the Help Manager will also display this list.

The types are divided into the following categories:

- Standard types (**BOOL**, **BYTE**, etc.)
- Defined types (structures, enumeration types, etc.)
- Standard function blocks (for the declaration of instances)
- Defined function blocks (for the declaration of instances)

The DDS supports all IEC 61131-3 standard types.

7.2.12 AT declaration

If the variable is to be directly linked to a certain address, the variable must be declared with the keyword AT.

The advantage of such an approach is that an address may be assigned a more explicit name, and that any changes to an input or output signal need be made at one location only (in the declaration).

Tip!

Note that no write access is possible to variables assigned to an input.

Furthermore, AT declarations can be made for local and global variables only, not for the input and output variables of organization units.

Examples:

```
bTrip_b AT %QX1.0.0: BOOL;
bRight_b AT %IX1.0.1: BOOL;
bReverse_b AT %MX2.2: BOOL;
```

Tip!

Boolean variables assigned to a byte, word or DWORD address subject a whole byte to TRUE or FALSE. not just the first bit after the offset.

7.2.13 Syntax colouring

All editors provide visual assistance for implementation and variable declaration.

- Coloured text helps to avoid errors or detect errors faster. (Unfinished comments will be detected immediately, keywords will be written correctly, etc.)

The following colour code is applied:

Blue	Keywords
Green	Comments in text editors
Pink	Boolean values (**TRUE**, **FALSE**)
Red	Incorrect input (e. g. invalid time constant, keyword written in lower case ...)
Black	Variables, constants, assignment operators ...

7.2.14 Short mode

The declaration editor provides the possibility to use the short form mode.

- The short form mode is activated by completing a line with **<Ctrl>+<Enter>**.

The following short forms are supported:

- All identifiers except the last one in a line become variable identifiers in the declaration.
- The declaration type is determined by the last identifier in the line, where:

`B` or `BOOL`	is	`BOOL`
`I` or `INT`	is	`INT`
`R` or `REAL`	is	`REAL`
`S` or `STRING`	is	`STRING`

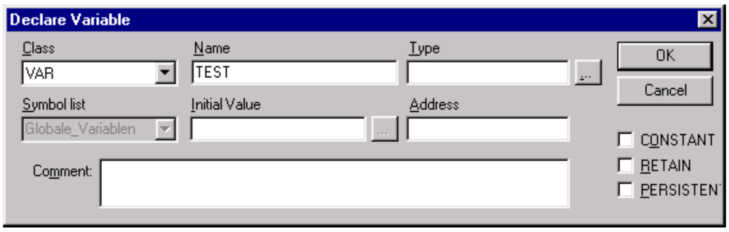
- If these rules did not help to define a type, the type will be `BOOL` and the last identifier is not used as a type (①).
- Each constant becomes an initialization or a string length depending on the declaration type (②, ③).
- An address (as in `%MD12`) is extended by the `AT` attribute (④).
- A text behind a semicolon (;) becomes a comment (③).
- All other characters in the line are ignored (such as the exclamation mark in in ⑤, for example).

Examples:

	Short form	Declaration
①	A	`A: BOOL;`
②	A B **I** 2	`A, B: INT := 2;`
③	ST **S** 2; String	`ST: STRING(2); (* String *)`
④	X %MD12 **R** 5; Number	`X AT %MD12:REAL := 5.0; (* Number *)`
⑤	B!	`B: BOOL;`

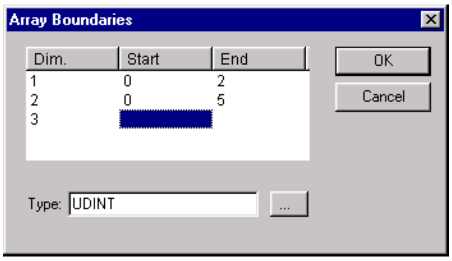
7.2.15 Auto declaration

If the option **Auto declaration** in the dialog box *Option*, category *Editor* is activated, the following dialog box will appear in all editors on entry of a not-yet-declared variable.



- Use combination box **Class** to select the variable class.
- Enter the variable name in text field **Name** (the input field is pre-assigned with the variable name entered in the editor).
- Enter the variable type in text field **Type** (the input field is pre-assigned with type `BOOL`).
- Use the button **...** to call the Help Manager for a selection of all available types.
- Use text field **Initial value** to assign a value to the variable, otherwise the standard initial value will be used.
- Use check boxes **CONSTANT** (constant) and **RETAIN** (battery support) to define whether the quantity is a constant or a retentive Retain variable.

If dialog box *Type* is used to select variable **ARRAY**, a dialog is displayed for array boundary definition. The illustration below shows a two-dimensional UDINT-type (unsigned double integer) array.

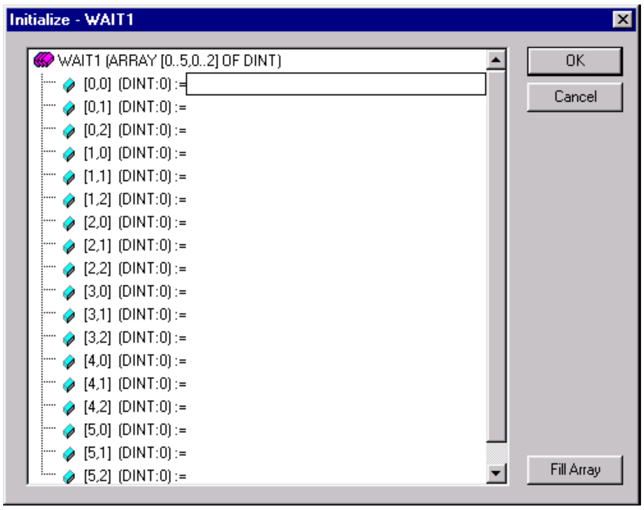


This organization unit can be used to generate a three-dimensional array. Use *Start and End* to define the boundaries of each dimension.

Use the button **...** to define the array data type. If the dialog is exited with **OK**, the system generates an IEC-format variable declaration.

```
Example: ARRAY[0..5, 0..2] OF INT
```

The variable declaration dialog offers dialog box *Initial value* to enter an initial value for the variable to be declared. If this is an array or a structure, button **...** or **<F2>** (cursor must be in dialog box *Initial value*) can be used to open a special initialization dialog. Other types (INT, BYTE) respond to opening the Help Manager dialog.



The initialization dialog for an array lists the array elements. A mouse click behind the := opens an edit box to enter the initial value.

The initialization dialog for a structure displays the individual components in a tree diagram where the variable name is followed by component type and default initial value in brackets, and an :=. Clicking behind here opens an edit box where the desired initial value may be entered. If the component is an ARRAY, the initialization dialog can be opened by clicking on the plus sign to enter initial values.

If the initialization dialog is exited with **OK**, the box *Initial value* displays the initialization of array or structure in IEC format.

```
Example: x:=5,field:=2,3,struct2:=(a:=2,b:=3)
```

Use field *Address* to bind the variable to be declared to an IEC address (AT declaration). Use input field *Comment* to enter information, such as changes, for example. Use **<Ctrl> +<Enter>** for line breaks.

Use **OK** to close the declaration dialog and to accept the entry to the variable (in accordance with IEC syntax) in the associated declaration editor.

Tip!

The variable declaration dialog can also be opened via **Edit→Declare variable**.

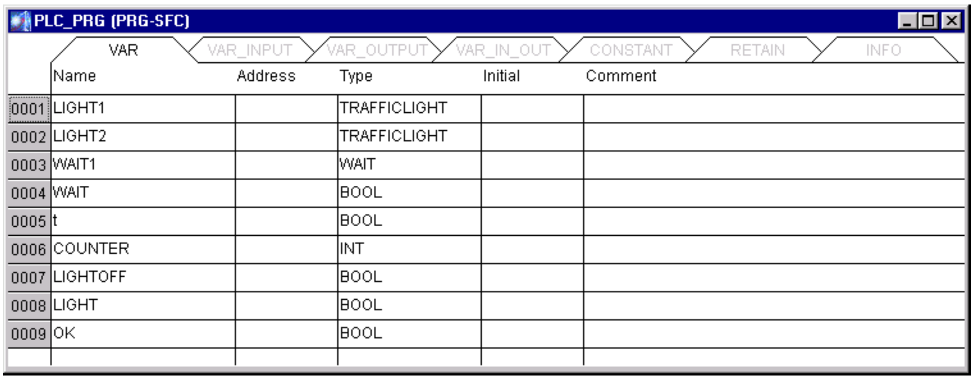
If the cursor is over a variable, the dialog box *Declare variable* can be opened in offline mode with the current variable-specific settings via **<Shift>+<F2>**.

7.2.16 Line numbers in the declaration editor

- In offline mode, a whole text line can be selected by clicking the line number.
- In online mode, in the case of a structured variable, the variable in a line will be opened or closed by clicking on the line number.

7.2.17 Declarations as tables

If control box **Declarations as tables** in the dialog box *Options*, category *Editor* is activated, variables in the table can be edited as table instead of using the declaration editor:



- This table is arranged as a card index box with tab cards for input, output, local and input/output variables. Select the tab card for the respective variable category by clicking a tab and edit the variables.

The following input fields are available for each variable:

Name	Variable identifier
Address	Address linked to the variable (AT declaration)
Type	Variable type (enter the function block name on instancing a function block).
Initial	Variable initialization value (according to assignment operator ":=")
Comment	Comment

- You can toggle between declaration editor and Declarations as tables at any time.
- New variables can be inserted using the command **Insert→New declaration**.

7.2.17.1 Inserting new variable into the declaration table

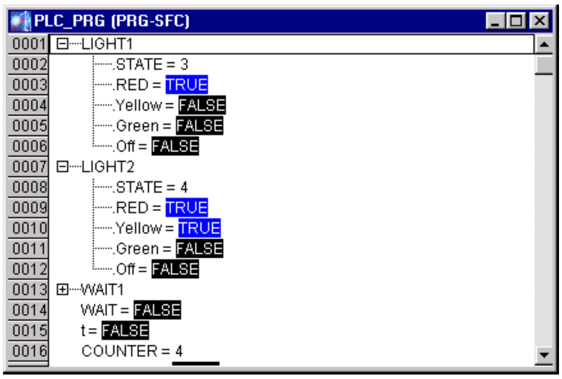
Icon: -	Menu: **Insert→New declaration**	Keyboard: -

Use this command to insert a new variable into the declaration table in the declaration editor.

- If the cursor is currently in a table cell, the new variable will be inserted in front of this line, otherwise at the beginning of the table.
- It is also possible to insert a new declaration at the end of the table by pressing the **<right arrow>** key or the **<Tab>** key in the last table cell.
- Execution of the command results in a variable with a pre-assigned "Name" in field *Name* and BOOL in field *Type*. These values can be changed as necessary. Name and type are sufficient for a complete variable declaration.

7.2.18 Declaration editor in online mode

In online mode, the declaration editor is a monitor window.



Every line contains a variable followed by an equal sign (=) and the variable value.

- Three question marks (???) will appear if the variable has not been defined yet.

Multi-element variables

Multi-element variables are identified with a plus sign.

- Press **<Enter>** or double-click the variable to open it and to list all components. The variable will then be identified with a minus sign.
- Double-click or press **<Enter>** again to hide the components and to return the plus sign.

Single-element variables

Press **<Enter>** or double-click a single-element variable to open the dialog box for writing a variable. The current variable value can be changed by entering a new value. In the case of Boolean variables, the value will be toggled without dialog box display.

The new value (now represented in a different colour) will not be written to the control immediately.

- Thus any number of variables can be modified and then written to the control in one go (cycle-consistent).

7.2.19 Comment

User comments must start and end with the special character sequences `(*` and `*)`.

Comments are allowed in all text editors and there at any location, such as declarations, IL and ST and user-defined data types.

Use **Project→Options** Category *Build options* to activate or deactivate nested comments.

FBD, LD and CFC allow comments to be entered for every network.

- Find the network to be commented and select the command **Insert→Comment**.

In SFC, comments for the step can be entered under *Edit step attributes*.

Tip!

Positioning the mouse pointer briefly over a variable in online mode will display a tool tip with the variable's type and any comments.

Only the variable type is displayed in offline mode.

7.2.19.1 Pragma instruction

- The pragma instruction controls the compile process and is always written with additional text in a program line or in a separate declaration editor line.
- This instruction is given in curly brackets and is case-insensitive.
  `{<Instruction>}`
- Should the compiler be unable to interpret the instruction text, the complete pragma is treated as a comment and ignored, while a warning is given for this process.
  `Ignore compiler directive <instruction text>`
- The pragma instruction affects the line in which it occurs or the subsequent ones until it is revoked by another pragma instruction or the same pragma instruction is executed with different parameters. The pragma instruction also ends at the end of an implementation, a global variable list or a type declaration.
- The opening bracket may directly follow a variable name. Brackets that belong together must be in the same line.

Pragma instructions must be written in the following syntax:

`{flag[<flags>] [off | on]}`

This pragma may influence the properties of a variable declaration.
`<flags>` may be a combination of the following flags.

The following pragma is currently available:

noinit	Variable is not initialized
nowatch	Vaiable not displayed (no monitor).
nowrite	Vaiable exported into the icon file without write access.
noread	Vaiable exported into the icon file without read access.
noread, nowrite	Vaiable not exported into the icon file.

Modifier **on** makes the pragma effective for all subsequent variable declarations until revoked by pragma {flag **off**}. The pragma may also be overwritten by another {flag<flags>on} pragma.

Without modifier **on** or **off**, the pragma will affect only the current variable declaration.

Examples

Variable a is not initialized and not displayed. (Monitor)
Variable b is not initialized.

```
VAR
      a:INT{flag noinit, nowatch};
      b:INT{flag noinit};
END VAR
```

```
VAR
      {flag noinit, nowatch on}
      a:INT;
      {flag noinit on}
      b:INT;
      {flag off}
END VAR
```

Neither variable is initialized.

```
{flag noinit on}
VAR
      a:INT;
      b:INT;
END VAR
{flag off}
```

```
VAR
      {flag noinit on}
      a:INT;
      b:INT;
      {flag off}
END VAR
```

The noread and nowrite flags may be used to assign restricted access rights to individual variables. By default, the variable has the same setting as the organization unit. Should it have no read and write access, it will not be exported into the icon file.

If the organization unit is given read and write access, the following pragma allows variable a to be exported with write access only and variable b not at all.

``VAR a:INT {flag noread}; b:INT {flag noread,nowrite}; END_VAR```	```VAR {flag noread on} a:INT; {flag noread,nowrite on} b:INT; {flag off} END_VAR```

Variables a and b are not exported into the icon file.

``{flag noread, nowrite on} VAR a:INT; b:INT; END_VAR {flag off}```	```VAR {flag noread, nowrite on} a:INT; b:INT; {flag off} END_VAR```

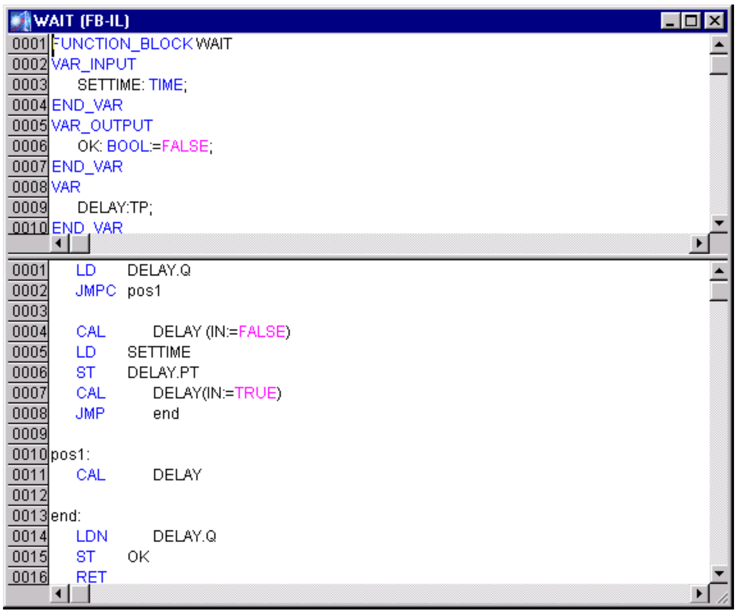
The pragma is inherited by the subordinate variable declarations.

```
a:afb;
.
.
.
FUNKTION_BLOCK afB
VAR
            b:bfb{flag nowrite};
            c:INT;
END_VAR
.
.
.
FUNKTION_BLOCK bfB
VAR
            d:INT{flag noread};
            e:INT{flag nowrite};
END_VAR
```

a.b.d is not exported.
a.b.e is exported with read access only.
a.c is exported with read and write access.

7.3 Text editors

The DDS text editors used for the implementation component (**Instruction list editor** and **Structured text editor** offer the standard functionality of Windows text editors and support syntax colouring.



7.3.1 Commands in the “Insert” menu

7.3.1.1 Operator

Icon:	-	Menu:	**Insert→Operator**	Keyboard:	-

Use this command to display all operators available in the current language in a dialog box.

- Select one of the operators and click **OK** to insert the highlighted operator at the current cursor position.

7.3.1.2 Operand

Icon:	-	Menu:	**Insert→Operand**	Keyboard:	-

Use this command to display all variables in a dialog box.

Select between lists of global, local or system variables.

- Select one of the operands and click **OK** to insert the highlighted operand at the current cursor position.

7.3.1.3 Function

Icon:	-	Menu:	**Insert→Function**	Keyboard:	-

Use this command to display all functions in a dialog box.

Select between a list of user-defined or standard functions.

- Select one of the functions and click **OK** to insert the highlighted function at the current cursor position.
- If the check box **With arguments** was activated in the dialog box, the input variables required for the function will be inserted as well.

7.3.1.4 Function block

Icon: -	Menu: **Insert→Function block**	Keyboard: -

Use this command to display all function blocks in a dialog box.

Select between a list of user-defined or standard function blocks.

- Select one of the function blocks and click **OK** to insert the highlighted function block at the current cursor position.
- If the option **With arguments** was activated in the dialog box, the in/output variables required for the function block will be inserted as well.

Organization unit call with output parameters

The output parameters of a called organization unit can be assigned directly in the call in the text languages IL and ST.
Example: Output parameter out1 of afbinst is assigned to variable a.

```
IL: CAL afbinst(in1:=1, out1=>a)
ST: afbinst(in1:=1, out1=>a);
```

A multi-line organization unit call is possible.

```
CAL CTU_inst(
 CU:=%IX1.0.0,
 PV:=(
 LD A
 ADD 5
 )
 )
```

7.3.2 Text editors in online mode

In online mode, breakpoints can be set and single steps can be processed in text editors. This combines with monitoring into the debugging function of a state-of-the-art Windows very high-level language debugger.

In online mode, the text editor window is vertically split in two.

- Normal program text is shown on the left.
- Variables and their respective values are shown on the right.

Tip!

The current variable values are displayed (monitoring) while the control is running.

Observe the following when monitoring expressions or bit-addressed variables.

The value displayed for bit-addressed variables is always the addressed bit value (monitor)

Positioning the mouse pointer briefly over a variable in online mode will display a tool tip with the variable's type and any comments.

Only the variable type is displayed in offline mode.

Multi-element variables

Multi-element variables (arrays, structures and instances of function blocks) are identifed with a plus sign in front of the identifier.

- Press **<Enter>** or double-click the variable to open it and to list all its components. The variable will then be identified with a minus sign.
- Double-click again or press **<Enter>** to hide the components and to return the plus sign.

7.3.2.1 Configuring the monitoring window

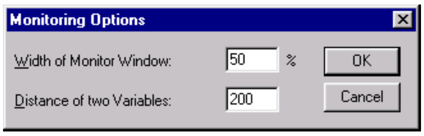
Icon: -	Menu: **Extras→Monitoring options**	Keyboard: -

Use this command to configure the monitoring window.

In online mode, the text editor window is vertically split in two.

- Normal program text is shown on the left.
- Variables and their respective values are shown on the right.

Open the dialog box *Monitoring options* to effect the following settings:



- Width of monitor window (in percent).
- Distance between two monitoring variables in a line.

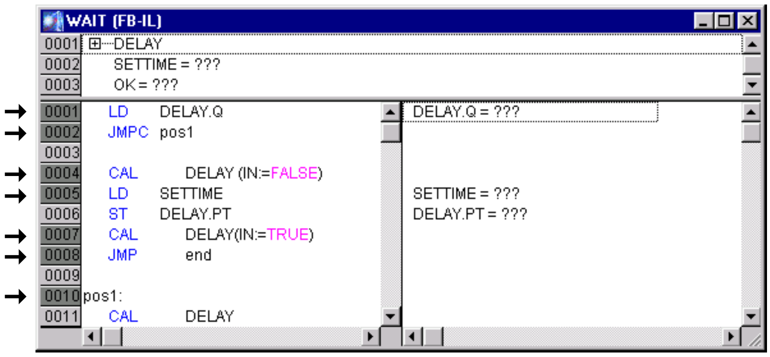
Distance 1 corresponds to one pixel in the selected resolution.

7.3.3 Breakpoint positions

Breakpoint positions are all program locations where variable values can change or program flow branches.

- As the DDS internally combines several IL lines into one C code line, it is not possible to set breakpoints in every line.
- Exception: Function calls:
  Breakpoints must be set in the functions as necessary.

Possible breakpoint positions are identified with a dark grey line number field:



Instruction list editor

The following breakpoint positions are possible in the instruction list editor:

- At the beginning of an organization unit
- On every `LD`, `LDN` (or if an `LD` is set directly behind a label, on this label)
- At every `JMP`, `JMPC`, `JMPCN`
- At every label
- At every `CAL`, `CALC`, `CALCN`
- At every `RET`, `RETC`, `RETCN`
- At the end of the organization unit

Structured text editor

The following breakpoint positions are possible in the Structured text editor:

- At every assignment
- At every `RETURN` and `EXIT` instruction
- In lines where conditions are evaluated (`WHILE`, `IF`, `REPEAT`)
- At the end of the organization unit

7.3.4 What happens at a breakpoint?

If a breakpoint is reached in the control, the section containing the associated line will be displayed on screen.

- The line number field of the line where processing has stopped is shown in red.
- User program processing is stopped in the control.

Click **Online→Start** to continue the program after a stop caused by a breakpoint.

Click **Online→Single step over** or **Online→Single step in** to continue the program to the next breakpoint position.

- If the instruction where the program stopped is a `CAL` command or if the lines before the next breakpoint position contain a function call, click **Online→Single step over** to skip this function call, and **Online→Single step in** to branch into the called organization unit.
- A program stop at a breakpoint will freeze all tasks. Once a breakpoint has been attended to, the program will continue from the location where it stopped.

Note!

Breakpoints should be set very carefully to avoid unexpected problems during the running process.

Setting a breakpoint changes the automation system's processing schedule.

If the program is stopped at a breakpoint, the drive will respond as defined in **Project→Exception handling**. (📖LEERER MERKER)

7.3.5 Line numbers of the text editor

The line numbers of the text editor specify the number of each text line for an implementation of an organization unit.

Offline mode

A whole text line can be highlighted in offline mode by clicking the line number.

Online mode

In online mode, the background colour of the line number signals the breakpoint status of every line.

- **Dark grey:**This line is a possible position for a breakpoint.
- **Light blue:**This line contains a breakpoint.
- **Red:** Current program processing location.

In online mode, the breakpoint status of this line can be changed with a mouse click.

7.4 Network editors (general)

The DDS network editors can be used for programming in the graphically oriented languages FBD, LD and CFC.

Both network editors allow jump labels, network commands and the commands **Insert→Network (after)**/**Insert→Network (before)**.

7.4.1 Jump labels

Each network has a jump label that may also be blank.

This label can be edited by clicking next to the network number in the first line of the network. It is now possible to enter a label followed by a colon.

7.4.2 Network comments

Every network can be commented in several lines. To distinguish them from program text, comments are shown in grey.

7.4.2.1 Options for network comments

Icon: -	Menu: **Extras→Options**	Keyboard: -

Use this command to define the following options for network comments:

Maximum comment size

Use the field *Maximum comment size* to define the maximum number of lines to be available for a network comment (preset: 4).

Minimum comment size

Use the field *Minimum comment size* to define the number of lines to be generally available for comments (preset: 0).

- If this field specifies 2, for example, every network will start with two blank comment lines after the label line. The lower the value, the more networks can be displayed on screen.
- If the minimum comment size is greater than 0, click the associated comment line to enter a comment.
- If the minimum comment size is 0, first select the network to be commented and then click **Insert→Comment** to insert a comment line.

7.4.3 Inserting a new network

7.4.3.1 Network (after)/Network (before)

Icon: -	Menu: **Insert→Network (after)** **Insert→Network (before)**	Keyboard: **<Ctrl>+<T>** -

Use this command to insert a new network in front of or behind the current network in the FBD or LD editor.

- Change the current network (dotted rectangle and network number) by clicking the network number.
- Click keeping the **<Umschalt>** key depressed to select all networks between the current and the clicked network.

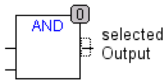
7.4.4 Inputs/Outputs on the fly

This function serves to create inputs and outputs whether via keyboard entry or by means of a selection field.

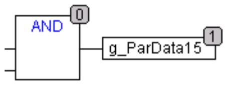
Tip!

This function saves you from drawing and connecting inputs, outputs, and function blocks in the CFC editor.

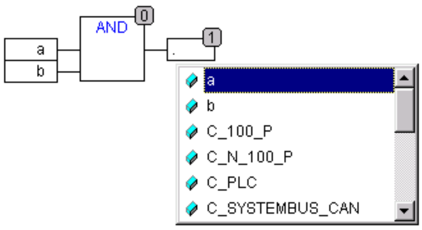
Select, for example, an input or output in the CFC editor.



Enter the variable name directly via the keyboard. If the variables are already available the name must be written correctly. If the variable is not available, it must be set in the variable declaration.



If the name or the instance name of a function block or structure is entered with a point, a list of all variables is displayed.



7.4.5 Network editors in online mode

Breakpoints

FBD and LD editors allow breakpoints to be set to networks only.

- The network number field of a network with a breakpoint is displayed in blue.
- Processing stops before the network with the breakpoint. In this case the network number field is displayed in red.
- In single-stepping, the process jumps from network to network.

Monitoring

All values are monitored at the inputs and outputs of network organization units.

Writing values in FBD

Double-click a variable to open a dialog box where the current variable value can be changed (Boolean variables are toggled, and no dialog box will be displayed).

- The new value is displayed in red.
- **Online→Write values** sets all changed variables to the new value and displays them in black.

Tip!

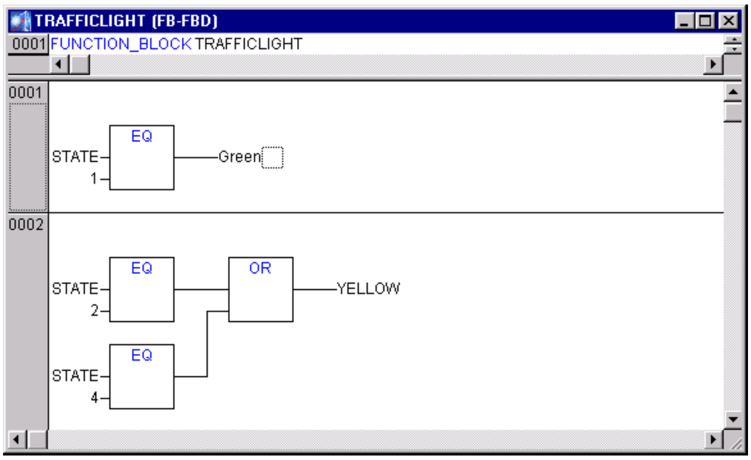
Positioning the mouse pointer briefly over a variable in online mode will display a tool tip with the variable's type and any comments.

Only the variable type is displayed in offline mode.

7.5 Function block diagram editor

The function block diagram editor is a graphic editor that uses a list of networks.

Each network contains a structure that each represents a logical or arithmetic expression, a function block call, a function, a program, a jump or a Return instruction.



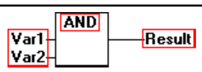
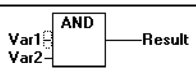
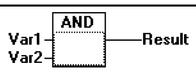
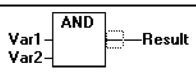
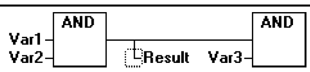
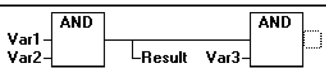
Tip!

The most essential FBD editor commands are also available in the shortcut menu (right mouse key or **<Ctrl>+<F10>**)

7.5.1 Cursor positions in FBD

Every piece of text represents a possible cursor position. The selected text is highlighted in blue and can now be changed.

Otherwise the current cursor position is identified with a dotted rectangle. All the possible cursor positions are listed below together with an example:

	Every text box (possible cursor positions identified with a frame)
	Every input
	Every organization unit
	Outputs if followed by an assignment or jump
	The intersection upon an assignment, jump or Return instruction
	The intersection directly before an assignment
	Behind the last (right-hand) object of a network ("last cursor position")

7.5.2 Placing the cursor

The cursor can be set to a certain position with a mouse click or the keyboard.

- Use the arrow keys to jump to the next cursor position in the selected direction. This will reach all cursor positions including the text fields.
- If the last cursor position is selected, use the arrow keys **<up>** or **<down>** to select the last cursor position of the preceding or subsequent network.
- An empty network contains nothing but three question marks (???). Click behind these to select the last cursor position.

7.5.3 Commands in the "Insert" menu

7.5.3.1 Assignment

Icon:	Menu: **Insert→Assignment**	Keyboard: **<Ctrl>+<A>**

Use this command to insert an assignment.

Insertion is made, dependent on the selected position

- directly before the selected input,
- directly behind the selected output,
- directly before the selected intersection
  or
- at the end of the network.

Then the text "???" can be selected and substituted with the variable. Alternatively, use the Help Manager to do so.

To add another assignment to an existing one, use the command **Insert→Output**.

Note!
This command is also available in the ladder diagram editor.

7.5.3.2 Jump

Icon:	Menu: **Insert→Jump**	Keyboard: **<Ctrl>+<L>**

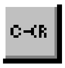
Use this command to insert a jump.

Insertion is made, dependent on the selected position

- directly before the selected input,
- directly behind the selected output,
- directly before the selected intersection
  or
- at the end of the network.

Then the text "???" can be selected and substituted with the jump label to be jumped to.

7.5.3.3 Return

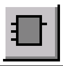
Icon: 	Menu: **Insert→Return**	Keyboard: **<Ctrl>+<R>**

Use this command to insert a **RETURN** instruction.

Insertion is made, dependent on the selected position

- directly before the selected input,
- directly behind the selected output,
- directly before the selected intersection
  or
- at the end of the network.

7.5.3.4 Operator

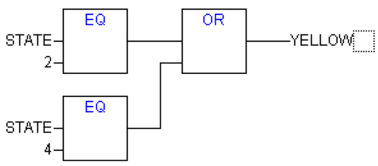
Icon: 	Menu: **Insert→Operator**	Keyboard: **<Ctrl>+<B>**

Use this command to insert operators, functions, function blocks and programs.

- It first adds an AND operator.
- It can be converted by overwriting the organization unit type, e. g. AND by OR.
- Use the Help Manager **<F2>** to select the required organization unit.
- The formal names of inputs and outputs are displayed for functions and function blocks.
- There is a variable instance field above the box for function blocks. If the organization unit type is changed and thus an unknown function block called, the system displays an operator box with two inputs and the specified type.
- If the instance field is selected,**<F2>** can be used to call the Help Manager with the categories for variable selection.
- A new organization unit is inserted depending on the selected position.

Example:

The current cursor position is identified by a small rectangular box in the example behind the assignment YELLOW.



- If the new organization unit has a different minimum number of inputs, they will be attached.
- If the new organization unit has a lower maximum number of inputs, the last inputs including the preceding branches will be deleted.

All organization unit inputs that could not be connected, are identified "???". .

- Click this text to change it to the required constant or variable.

Insertion is made dependent on the selected position.

Input selected

If selecting an input, the operator will be inserted in front of this input.

- The first input of this operator will be connected to the branch to the left of the selected input.
- The output of the new operator will be connected to the selected input.

Output selected

If selecting an output, the operator will be inserted behind this output.

- The first input of the operator will be connected to the selected output.
- The output of the new operator will be connected to the branch the selected output was connected to.

Organization unit, function or function block selected

If selecting an organization unit, function or a function block, the new operator will replace the old element.

- As far as possible, the branches will be connected as before the replacement.
- If the old element had more inputs than the new element, the branches that cannot be connected will be deleted. The same applies to the outputs.

Jump or Return selected

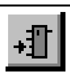
If selecting a jump or a Return, the organization unit will be inserted in front of this jump or Return.

- The first input of the operator will be connected to the branch to the left of the selected element.
- The operator output will be connected to the branch to the right of the selected element.

Last cursor position in network selected

- If selecting the last cursor position of a network, the organization unit will be inserted behind the last element.
- The first input of the organization unit will be connected to the branch to the left of the selected position.

7.5.3.5 Input

Icon: 	Menu: **Insert→Input**	Keyboard: **<Ctrl>+<U>**

Use this command to insert an operator input.

The number of inputs is variable for many operators (e. g. `ADD` may have two or more inputs).

Such an operator can be extended by an input as long as the input in front of which the new input is to be inserted - or the operator itself if a bottom-most input is to be added - is selected.

The inserted input is pre-assigned with ”???”.

- Click this text to change it to the required constant or variable. Alternatively, use the Help Manager (**<F2>**) to do so.

Note!

This command is also available in the ladder diagram editor.

7.5.3.6 Output

Icon:	Menu: **Insert→Output**	Keyboard: -

Use this command to add an additional assignment to an already existing assignment.

This function assists the generation of so-called assignment combs, i.e. the assignment of the value currently assigned to the line to several variables.

- If the selected intersection is over an assignment or the directly preceding output, another assignment will be added behind those already in existence.
- If the selected intersection is directly in front an assignment, an assignment will be inserted in front of this assignment.

The inserted output is pre-assigned with ”???”.

- Click this text to change it to the required variable. Alternatively, use the Help Manager (**<F2>**) to do so.

Note!

This command is also available in the ladder diagram editor.

7.5.4 Commands in the “Extras” menu

7.5.4.1 Negation

Icon:	Menu: **Extras→Negate**	Keyboard: **<Ctrl>+<N>**

Use this command to negate inputs, outputs, jumps or **RETURN** instructions.

The symbol for the negation is a small circle on a connection.

- Selected inputs will be negated.
- Selected outputs will be negated.
- Selected jumps or **RETURNs** will have the input of this jump or RETURN negated.

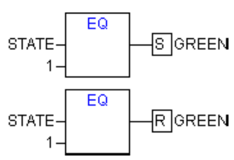
A negation can be deleted by another negation.

7.5.4.2 Set/Reset

Icon:	Menu: **Extras →Set/Reset**	Keyboard: -

Use this command to define outputs as Set or Reset outputs.

A gate with Set output is represented with an [S] and a gate with Reset output with an [R]:



- A Set output is set to **TRUE** if the associated gate return**TRUE**. The output now retains this value even if the gate jumps back to **FALSE**.

- A Reset output is set to **FALSE** if the associated gate returns**TRUE**. The output now retains this value even if the gate jumps back to **FALSE**.

If the command is executed more than once, the output toggles between Set, Reset and normal output.

7.5.4.3 Zoom

Icon: -	Menu: Extras→Zoom	Keyboard: <Alt>+<Enter>

Use this command to load a selected organization unit into its editor.

- If the organization unit is from a library, the Library Manager will be called on command execution.

7.5.4.4 Open instance

Icon: -	Menu: Extras→Open instance	Keyboard: -

This command corresponds to the command **Project→Open instance**.

7.5.5 Commands in the “Edit” menu

7.5.5.1 Cut, Insert, Copy andDelete

Icon: -	Menu: Edit→Cut Edit→Insert Edit→Copy Edit →Delete	Keyboard: <Ctrl>+<X> <Ctrl>+<V> <Ctrl>+<C> <Del>

Cut, Copy, Delete

- Selecting an intersection cuts, copies or deletes the underlying assignments, jumps or **RETURN** instructions.
- Once selected, an organization unit will be cut, copied or deleted along with all branches connected to the inputs, with the exception of the first branch.
- Otherwise, the whole branch before the cursor position will be cut, copied or deleted.

Insert

After a **Copy** or **Cut**, the copied or cut section is saved to the clipboard and can be inserted as often as required.

- To do so, first select the insertion position. Inputs and outputs are valid insertion positions.
- If an organization unit was loaded into the clipboard (in this case, all connected branches with the exception of the first have also been transferred to the clipboard), the first input will be connected to the branch before the insertion position.
- Otherwise, the whole branch before the insertion position will be replaced with the contents of the clipboard.
- In every case, the last-inserted element will be connected to the branch to the right of the insertion position.

Tip!

Cut and **Insert** solve the following problem:

A new operator is inserted in the middle of a network. The branch to the right of the operator is now connected to the first input, but should be connected to the second input.

Select the first input and then **Edit→Cut**. Then select the second input and click **Edit→Insert**.

The branch is now connected to the second input.

7.5.6 The FBD editor in online mode

In the FBD, breakpoints can only be set to networks. Where a breakpoint was set to a network, the network number field is shown in blue. Processing stops in front of the network with the breakpoint, and the network number field turns red. In single-stepping, the process jumps to every single network.

Each variable is displayed with its current value.

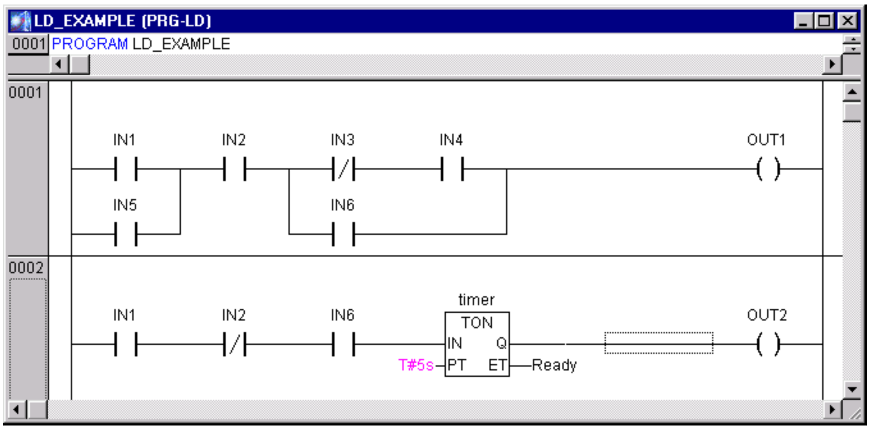
Tip!

Only the first variable of the expression will be monitored (visible) if the input of a function block is an expression.

- Double-click the variable to open the write variable dialog.
- The current value of the variable can then be changed.
- No dialog appears for Boolean variables; these are toggled.
- The new value is cyan and remains as-is.
- Execution of menu command **Online→Write values** sets all variables to the selected values and displays them in black.

7.6 Ladder diagram editor

The ladder diagram editor is a graphic editor that uses a sequence of networks.



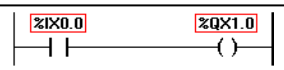
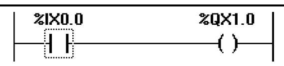
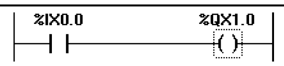
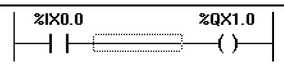
Tip!

The most essential LD editor commands are also available in the shortcut menu (right mouse key).

7.6.1 Cursor positions in LD

Organization units with EN inputs and other organization units linked thereto are used as in the function block diagram editor.

The cursor can have the following positions (function block and program calls can be used like contacts):

	Every text field (possible cursor positions identified with a frame)
	Every contact or function block
	Every coil
	The connection link between contact and coil

7.6.2 Commands in the “Insert” menu

7.6.2.1 Contact

Icon:	Menu: **Insert→Contact**	Keyboard: **<Ctrl>+<K>**

Use this command to insert a contact in front of the position selected in the network.

- If the selected position is a coil or a connection link between contacts and coil, the new contact is connected in series to the previous contacts.

The inserted contact is pre-assigned ”???”.

- Click this text to change it to the required constant or variable. Alternatively, use the Help Manager (**<F2>**) to do so.

7.6.2.2 Parallel contact

Icon:	Menu: **Insert→Parallel contact**	Keyboard: **<Ctrl>+<R>**

Use this command to insert a contact in parallel to the position selected in the network.

- If the selected position is a coil or a connection link between contact and coil, the new contact is connected parallel to the previous contacts.

The inserted contact is pre-assigned ”???”.

- Click this text to change it to the required constant or variable. Alternatively, use the Help Manager (**<F2>**) to do so.

7.6.2.3 Coil

Icon:	Menu: **Insert→Coil**	Keyboard: **<Ctrl>+<L>**

Use this command to insert a coil parallel to the already existing coils.

- If the selected position is a connection between contacts and coils, the new coil will be the last coil.
- If the selected position is a coil, the new coil will be inserted directly above it.

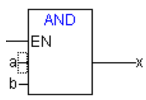
The coil is pre-assigned ”???”.

- Click the text to change it to the required variable. Alternatively, use the Help Manager (**<F2>**) to do so.

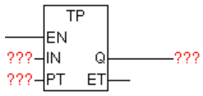
7.6.2.4 Insert at organization unit

Icon: -	Menu: **Insert→Insert at organization unit** **→Input** **→Output** **→Box** **→Assignment**	Keyboard: **<Ctrl>+<U>** **<Ctrl>+<A>**

This submenu to the **Insert** menu contains commands to add further elements to an already inserted organization unit with EN input.



An organization unit with EN may be given the name of a function block so that **Insert→Insert at organization unit** can be executed.



In this example, **AND** was overwritten with the name of timer **TP** .

- The commands in this submenu can be executed at the same cursor positions as the associated commands in the FBD.

Input	Use Input to add a new input to the organization unit.
Output	Use Output to add another assignment to an organization unit output.
Box	Use Box to add a new organization unit to the selected one. The output of the new organization unit is connected to the selected input. The organization unit is pre-assigned AND.
Assignment	Use Assignment to add an assignment to a variable.

7.6.2.5 Jump

Icon: -	Menu: **Insert→Jump**	Keyboard: -

Use this command to insert a jump in parallel to the end of the existing coils.

- If the incoming line has a value "ON", the jump to the selected label will be carried out.
- The selected position must be the connection between contacts and coils or a coil.

The jump is pre-assigned "???".

- Click the text to change it to the required jump label.

7.6.2.6 Return

Icon: -	Menu: **Insert →Return**	Keyboard: -

Use this command to insert a `RETURN` instruction in parallel to the end of the existing coils.

- If the incoming line has a value "ON", processing of the organization unit in this network will be terminated.
- The selected position must be the connection between contacts and coils or a coil.

7.6.3 Organization units with EN inputs

Should the LD network need to be used to control other organization unit calls, it is necessary to insert an organization unit with an EN input or an organization unit with a Boolean input.

- An organization unit with EN inputs is connected in parallel to the coils.
- Based on one EN organization unit, the network can be further developed as in FBD.
- The commands for inserting elements at already inserted EN organization units are available in menu **Insert** , submenu **Insert at organization unit** .

Operators, function blocks, programs or a function with EN input respond like the associated organization unit in the FBD with the exception that its execution is controlled via the EN input. This input is connected to the connection line between coils and contacts. If this connection transfers the information "ON", the organization unit will be evaluated.

LD as FBD

Once an organization unit with EN input has been created, it will be possible to build up a network as in FBD. An EN organization unit can receive data from operators, functions and function blocks and also transfer data to such organization units.

In other words, programming of a network in the LD editor as in FBD merely requires prior insertion of an EN operator into a new network before further-developing it as in the FBD editor. A network developed like this acts like the associated network in FBD.

7.6.3.1 Operator with EN

Icon:	-	Menu:	**Insert→Operator with EN**	Keyboard:	-

Use this command to insert an operator with EN input.

- The selected position must be the connection between contacts and coils or a coil.

The new operator is inserted in parallel to the coils below the selected one and is always an `AND`.

- This can be changed to any other operator by selecting and overwriting the text.
- Use the Help Manager (**<F2>**) to select the required operator from the list of supported operators.

7.6.4 Commands in the “Extras” menu

7.6.4.1 Paste after

Icon:	-	Menu:	**Extras→Paste after**	Keyboard:	-

Use this command to paste the contents of the clipboard as serial contact behind the selected position.

- This command can only be used if the contents of the clipboard and the selected position are contact networks.

7.6.4.2 Paste below

Icon:	-	Menu:	**Extras→Paste below**	Keyboard:	**<Ctrl>+<U>**

Use this command to paste the contents of the clipboard as parallel contact below the selected position.

- This command can only be used if the contents of the clipboard and the selected position are contact networks.

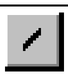
7.6.4.3 Paste above

Icon:	-	Menu:	**Extras→Paste above**	Keyboard:	-

Use this command to paste the contents of the clipboard as parallel contact above the selected position.

- This command can only be used if the contents of the clipboard and the selected position are contact networks.

7.6.4.4 Negation

Icon:		Menu:	**Extras →Negation**	Keyboard:	**<Ctrl>+<N>**

Use this command to negate a contact, coil, jump/`RETURN` instruction or an input or output of an EN organization unit at the current cursor position.

- A slash appears between the parentheses of a coil or the straight lines of a contact: (/) or I/I
- As in the FBD editor, jumps, returns, inputs and outputs of EN organization units are identified with a small circle in the connection.

The coil now writes the negated value of the input connection to the associated Boolean variable.

- A negated contact switches the status of the input to the output exactly when the associated Boolean variable returns the value `FALSE` .
- If a jump or return is highlighted, the input of the jump or return will be negated.

A negation can be deleted by another negation.

7.6.4.5 Set/Reset

Icon: -	Menu: **Extras →Set/Reset**	Keyboard: -

Use this command to define coils as Set or Reset coils.

A Set coil is identified with an "S" in the coil symbol.

If the network result is TRUE , the Boolean variable, as a consequence of the Set coil, will be set to TRUE . Otherwise, the variable will remain as it is.

If the network result is TRUE , the Boolean variable, as a consequence of the Set coil, will be set to TRUE . Otherwise, the variable will remain as it is.

A Reset coil never overwrites the value `FALSE` in the associated Boolean variable.

- A Reset coil is identified with an "R" in the coil symbol.

If the network result is TRUE , the Boolean variable, as a consequence of the Reset coil, will be set to FALSE. . Otherwise, the variable will remain as it is.

If the command is executed more than once, the coil toggles between Set, Reset and normal coil.

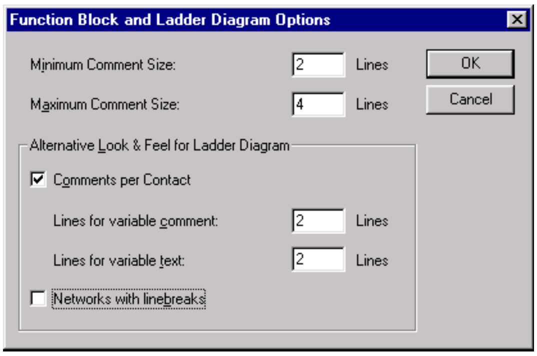
7.6.4.6 Open instance

This command corresponds to the command **Project→Open instance.**

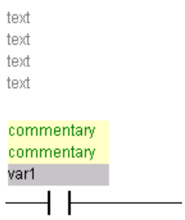
7.6.4.7 Options

Icon: -	Menu: **Extras →Options**	Keyboard: -

Use this command to open the dialog box *Function block and ladder diagram options* .



Completing the input fields as illustrated will update the associated contact with the following comment field.



Use the input fields **Minimum comment size** and **Maximum comment size** to enter a comment on the current contact or the current coil.

If check box **Comments per contact** is active, the input fields **Lines for variable comment** can be used to input a variable-specific comment, and **Lines for variable text** to specify a variable name.

If check box **Networks with line breaks** is active, the network will break depending on the window size.

7.6.5 The LD in online mode

- In online mode, all contacts and coils in **ON status** (TRUE) are marked blue in the LD.
- In online mode, all lines in TRUE status are marked blue in the LD.
- The values of the associated variables are displayed at function block inputs and outputs.
- Breakpoints can only be set to networks. In single-stepping mode, the process jumps to every single network one after the other.
- On active flow control, the number fields of the processed networks will be marked green.

Tip!

Positioning the mouse pointer briefly over a variable will display a tool tip with the variable's address, type and any comments.

7.7 CFC editor

Note!

If the error message

Internal error...: A CFC in this project is corrupted, and got restored. Please check its logics

should occur when the project is stored please proceed as follows:

- Do not delete the error message.
- Save an existing backup copy (automatic saving, last version) under another name. The automatically saved backup copy has the suffix *.asd and is saved in the same folder as the *.pro file.
- After that, confirm the error message DDS tries to correct the error automatically.
- Check the logic of the CFC editor.
- If errors are found use the backup copy. Delete the *.pro file and change the *.asd file into *.pro.

This measure ensures that you always have a reliable and up-to-date project version.

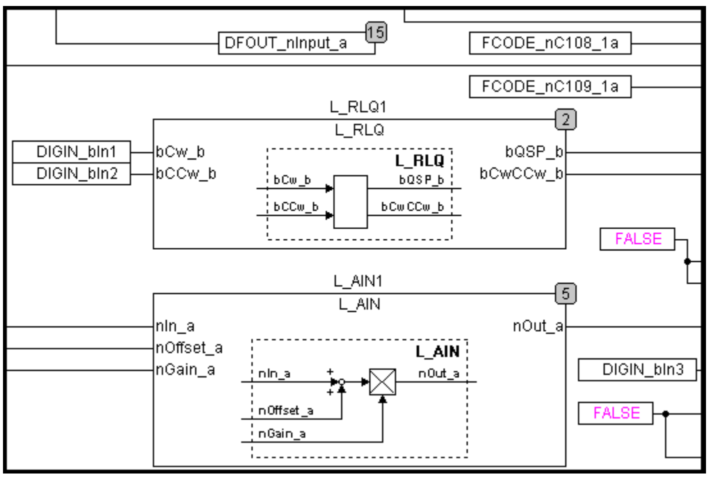
The CFC editor (*Continuous Function Chart* editor) does not use any networks. Instead, elements may be placed freely.

Note!

If you work with the CFC editor, the automatic backup should be active.

Project→Option Category *Load & Save*.

After extensions or changes the operations should be saved.



The following elements can be used in the CFC editor:

- Box
- Input
- Output
- Jump
- Label
- Return
- Comment

The inputs and outputs of these elements can be linked with the mouse. The connection link will be drawn automatically. The shortest connection link will be drawn, taking into account the existing links.

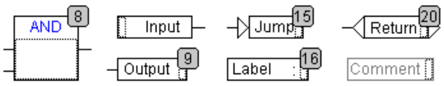
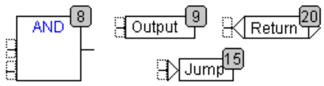
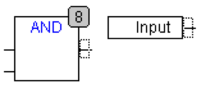
- The connection links will be auto-adapted when elements are moved.
- If a connection link cannot be drawn for space-related reasons, a red line will represent the connection between input and associated output and turn into a connection link as soon as there is enough space.

One of the advantages of the CFC editor over the standard FBD editor is that it allows direct insertion of feedbacks.

Tip!

The most essential CFC editor commands are also available in the shortcut menu (right mouse key)

7.7.1 Cursor positions in CFC

	Every text field (selected text is highlighted and can be edited.)
	Body of boxes, inputs, outputs, jumps, labels, returns and comments
	Inputs of boxes, outputs, jumps and returns
	Outputs of boxes and inputs

7.7.2 Selecting elements

Click its body to select an element

- For a multi-select, keep the **<Shift>** key depressed and click the respective elements one after the other, or keep the left mouse key depressed and draw a window across the elements to be selected.
- Use the command **Extras→Select all** to select all elements.

7.7.3 Copying and deleting elements

Use the standard Windows clipboard commands in the **Edit** menu to copy or delete one or more selected elements. (📖 7-2)

7.7.4 Moving elements

To move one or more selected elements, keep the **<Shift>** key depressed and use the arrow keys.

Elements may also be moved while keeping the left mouse key depressed.

- Releasing the left mouse key drops these elements at the current location.
- If the moved elements hide other elements at this location or exceed the editor size, they will not be moved. This is accompanied by an audible warning.

7.7.5 Commands in the “Insert” menu

7.7.5.1 Operator

Icon:	Menu: **Insert→Operator**	Keyboard: **<Ctrl>+<B>**

Use this command to insert an operator in the CFC editor.

The inserted operator is always an `AND`.

- It can be converted into any other operator, function, function block and program by selecting and overwriting the text.
- Use the Help Manager (**<F2>**) to select the required box from the list of supported boxes.
- If the new box has a different minimum number of inputs, they will be attached.
- If the new box has a lower maximum number of inputs, the last inputs including the preceding branches will be deleted.

7.7.5.2 Input

Icon:	Menu: **Insert→Input**	Keyboard: **<Ctrl>+<E>**

Use this command to insert an input in the CFC editor.

The inserted input is pre-assigned with ”???”.

- Click this text to change it into the required constant or variable. Alternatively, use the Help Manager **<F2>**) to do so.

The element Input can be used to read and transfer the value of a variable to another CFC element.

7.7.5.3 Output

Icon:	Menu: **Insert→Output**	Keyboard: **<Ctrl>+<A>**

Use this command to insert an output in the CFC editor.

The inserted output is pre-assigned with ”???”.

- Click this text to change it into the required variable. Alternatively, use the Help Manager (**<F2>**) to do so.

The element Output can be used to read and transfer the value of a variable to another CFC element.

7.7.5.4 Jump

Icon:		Menu:	**Insert→Jump**	Keyboard:	**<Ctrl>+<J>**

Use this command to insert a jump in the CFC editor.
The inserted jump is pre-assigned with the text ”???”.

- Click this text to change it into the required jump label to be jumped to.
- Insert a jump label with **Insert→Label**.

7.7.5.5 Label

Icon:		Menu:	**Insert→Label**	Keyboard:	**<Ctrl>+<L>**

Use this command to insert a jump label in the CFC editor.

- Click this text to change it into the required jump label.
- Insert a jump to this label using **Insert→Jump**.

7.7.5.6 Return

Icon:		Menu:	**Insert→Return**	Keyboard:	**<Ctrl>+<R>**

Use this command to insert a RETURN instruction in the CFC editor.

7.7.5.7 Comment

Icon:		Menu:	**Insert→Comment**	Keyboard:	**<Ctrl>+<K>**

Use this command to insert a comment in the CFC editor.

- Use **<Ctrl>+<Enter>** to add a line break in a comment.

7.7.5.8 Box input

Icon:	-	Menu:	**Insert→Box input**	Keyboard:	**<Ctrl>+<U>**

Use this command to insert a box input in the CFC editor.
With many operators the number of inputs may vary (e. g. the box ADD may have two or more inputs).

- In order to extend such an operator by one input, the operator itself must be selected first.

7.7.5.9 In pin / out pin

Icon:		Menu:	**Insert→In pin**	Keyboard:	-
Icon:		Menu:	**Insert→Out pin**	Keyboard:	-

These commands are available only while a macro is open and

- support the insertion of in or out pins as the inputs and outputs of a macro.
- receive no position index.

7.7.6 Commands in the “Extras” menu

7.7.6.1 Negation

Icon:	Menu: **Extras→Negation**	Keyboard: **<Ctrl>+<N>**

Use this command to negate inputs, outputs, jumps or RETURN instructions in the CFC editor.

The symbol for the negation is a small circle on a connection.

- Selected inputs will be negated.
- Selected outputs will be negated.
- If a jump or a RETURN is selected, the input of this jump or RETURN will be negated.

A negation can be deleted by another negation.

7.7.6.2 Set/Reset

Icon:	Menu: **Extras→Set/Reset**	Keyboard: **<Ctrl>+<T>**

Use this command to define outputs as Set or Reset outputs in the CFC editor.

The input of a Set output is identified with an [S], the input of a Reset output with an [R].

- A Set output is set to `TRUE` if its input returns `TRUE`. The output now retains this value even if its input status changes to `FALSE`.
- A Reset output is set to `FALSE` if its input returns `TRUE`. The output now retains this value even if its input status changes to `FALSE`.

If the command is executed more than once, the output changes between Set, Reset and normal output.

7.7.6.3 Mark all

Icon:	Menu: **Extras→Mark all**	Keyboard: **<Ctrl>+<I>**

This command marks all objects (blocks, instructions) in the active CFC editor
The marked objects can be edited simultaneously.

- Cut
- Undo
- Shift
  For this purpose an object must be clicked with the left mouse key. All objects can be shifted simultaneously.
- Negations
  For objects with inputs, negations are created.
- etc.

7.7.6.4 EN/ENO

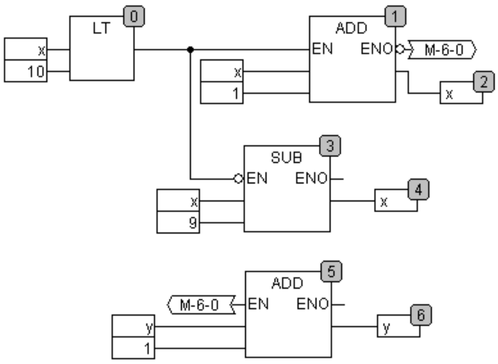
Icon:	Menu: **Extras→EN/ENO**	Keyboard: **<Ctrl>+<I>**

Use this command to extend a box selected in the CFC editor by an additional enable input EN and an enable output ENO for `BOOL-type variables`.

- A box with EN input/ENO output will only be executed if the EN input returns `TRUE`.
- After a box with EN input/ENO output has been executed, the ENO output returns `TRUE`, otherwise `FALSE`.

EN inputs / ENO outputs can also be negated with **Extras→Negation**.

Example of an enable concatenation:



The numbers in the top right-hand corner of the boxes specify the processing sequence.

1. In this example, x is to be initialized with 1 and y with 0.
2. **`SUB`** (3) and **`ADD`** (5) are not enabled.
3. As long as x < 10, **`ADD`** (1) is enabled and increases x by 1 every time (x=x+1).
4. If x = 10, the output of box **`LT(0)`** will return **`FALSE`** and enable **`SUB`** (3).
5. **`ADD`** (1) will be inhibited and enable **`ADD`** (5) via its ENO output.
6. **`SUB`** (3) and **`ADD`** (5) will be executed, x will be reset to 1 (x=x-9), and y will be increased by 1 (y=y+1).
7. **`SUB`** (3) and **`ADD`** (5) will be inhibited again via **`LT(0`**, and the process will be repeated from 3.

In this example, y counts how often x runs through the value range from 1 to 10.

7.7.6.5 Properties

Icon: -	Menu: **Extras →Properties**	Keyboard: -

Use this command to open the dialog box *Edit parameters* in the CFC editor, in which the constant input parameters (**`VAR_INPUT CONSTANT`**) of functions and function blocks of the selected box can be displayed and modified.

- These input parameters are not displayed directly in the CFC editor.
- Instead of selecting the box body and then **Extras→Properties**, the dialog box *Edit parameters* may also be opened by double-clicking the body of the associated box.

To modify the value of a constant input parameter (**`VAR_INPUT CONSTANT`**) in dialog box *Edit parameters*, select the associated entry in the column "Value".

- This value can then be edited with another mouse click or by pressing the **<Space bar>**.
- Press **<Enter>** to confirm a change, otherwise press **<Esc>** to dismiss it.

Click **OK** for a save exit from the dialog box. **Cancel** will not save any changes on exiting the dialog box.

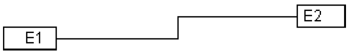
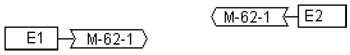
7.7.6.6 Connector

Icon: -	Menu: **Extras →Connector**	Keyboard: -

Use this command to connect elements via connectors in the CFC editor instead of connection links.

- Output and associated input are identified with a uniquely named connector.
- The name of the connector is automatically assigned by the program, but can be changed.

Where two elements are already linked by a connection that is now to be changed into a link with connectors, first select the output where the connection starts and then **Extras→Connector**.

Before command execution:	After command execution:
	

Tip!

Connections via connectors can be changed back into normal links by selecting the output of the connection and executing the command **Extras→Connector** again.

Changing the name of a connector

Note that the name of the connector is a feature of the output of a connection and will be saved together with it.

Editing a connector at an input:

- If the text in the connector is changed, the new name will be accepted for all associated connectors at inputs.
- The text cannot be changed into a name that already belongs to another connector. The name must be unique.

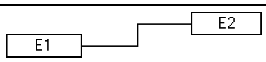
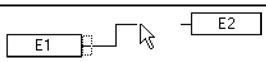
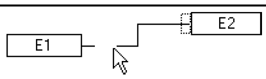
Editing a connector at an output:

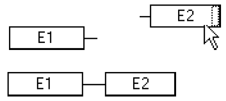
- A change to the text in the connector will also be reflected in the associated connector at the other box.

7.7.7 Creating connections

Inputs and outputs of elements can be connected by drawing a connection established through keeping the left mouse key depressed.

- An element input can be connected to exactly one element output.
- An element output can be connected to several element inputs.

	**There are several possibilities to connect the input of element E2 to the output of element E1:**
	1. Left-click the output of element E1, keep the left mouse key depressed, drag the mouse pointer to the input of element E2, and then release the left mouse key. – Dragging the mouse creates a connection between the output of element E1 and the mouse pointer.
	2. Left-click the input of element E2, keep the left mouse key depressed, drag the mouse pointer to the output of element E1, and release the left mouse key.

	3. Move either E1 or E2 until the output of element E1 touches the input of element E2.
	4. If element E2 is a box with an unassigned input, the mouse pointer can also create a connection between an output of E1 and the body of E2. – Releasing the left mouse key automatically creates a connection with the topmost unassigned input of E2. – If the box E2 has no unassigned input but is an operator that can be extended by one input, a new input will be created automatically.

Use method 1, 2 or 4 to connect the output and input of a box (feedback).

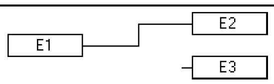
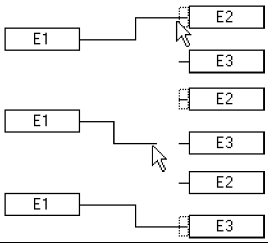
	Connecting two pins
	– Left-click a pin and keep the key depressed. – Drag the mouse to the required pin, and release the mouse key.

Tip!

Make sure not to accidentally leave the editor window during dragging as this will lead to screen scrolling.

Simple data types are type-checked during connection. Incompatible types cannot be connected.

7.7.8 Changing connections

	**A connection between the output of E1 and the input of E2 can be easily changed into a connection between the output of E1 and the input of E3.**
	Click on the E2 input and keep the left mouse key depressed while moving the mouse pointer from input E2 towards input E3.

7.7.9 Deleting connections

There are several possibilities to delete a connection between the output of element E1 and the input of element E2.

- Select the output of E1 and press **<Del>**, or execute command **Edit→Delete**. If the E1 output is connected to several inputs, several connections will be deleted.
- Select the input of E2 and press **<Del>**, or execute command **Edit→Delete**.
- Select the E2 input, keep the left mouse key depressed and follow the connection away from input E2. Release the mouse key in a free area to delete the connection.

7.7.10 Feedbacks

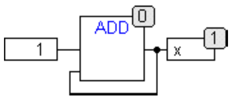
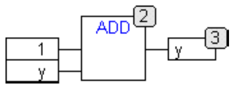
Contrary to the standard function block diagram editor, the CFC editor can display feedbacks directly.

Note that an internal intermediate variable will be generally created for the output of a box.

- With operators the data type of the intermediate variable depends on the highest-order data type of the inputs.
- With constants the data type depends on the lowest possible data type, i.e. data type `SINT` is assumed for constant '1'.

If an addition is carried out with feedback and constant '1', the first input returns data type `SINT`, whereas the second input remains undefined as a consequence of the feedback. Thus also the intermediate variable is `SINT-type`. Only then will the value of the intermediate variable be assigned to the output variable.

The illustration below shows an addition with feedback and an addition directly with a variable. Variables x and y are to be `INT-type` in this case:

Addition with feedback:	Addition directly with a variable:
	

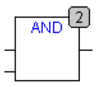
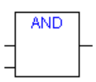
The two additions differ as follows:

- Variable y can be initialized with a nonzero value, whereas the intermediate variable of an addition with feedback needs a zero.
- The intermediate variable of the addition with feedback is `SINT-type`, that of the addition with variable y of `INT-type`.
- Variables x and y have different values from call 128. Although `INT-type`, variable x is assigned value –128 as the intermediate variable has overflown. Variable y is assigned value 128.

7.7.11 Processing sequence

The CFC editor assigns a processing number to boxes, outputs, jumps, returns and labels and processes the individual elements in this sequence at runtime.

- On element insertion, this number will be automatically assigned in a topological sequence (from left to right and from top to bottom).
- If the sequence has already been changed, the new element will be assigned the number of its topological descendant, and all higher numbers will be increased by one.
- Moving an element will not affect the number.
- The sequence influences the result and must therefore be changed under certain circumstances.
- If sequence display is activated, the element's processing number is displayed in a grey field in the top right-hand corner.

Processing sequence display on:	Processing sequence display off:
	

7.7.12 Commands in the “Extras” menu, submenu “Order”

7.7.12.1 Display

Icon: -	Menu: **Extras→Order→Display**	Keyboard: -

Use this command to switch the processing sequence display on and off in the CFC editor.

- The default is ON.
- A tick in front of the menu command indicates that the display is on.

7.7.12.2 Arrange topologically

Icon: -	Menu: **Extras →Order →Arrange topologically**	Keyboard: -

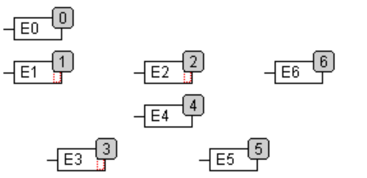
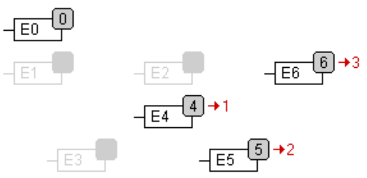
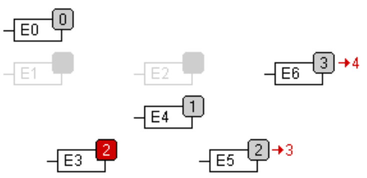
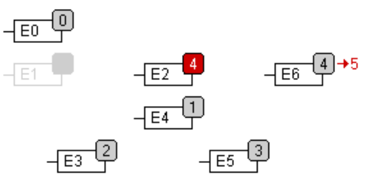
Use this command to arrange the selected elements in topological sequence in the CFC editor.

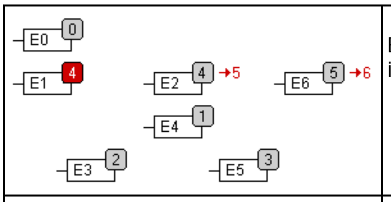
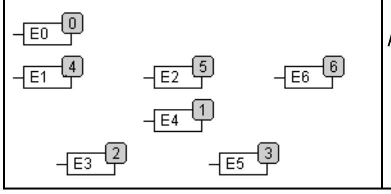
Elements are arranged in topological sequence if they are processed from left to right and from top to bottom, i.e. with topologically arranged elements, the number increases from left to right and from top to bottom. Only the element position is relevant in this case, not the connections.

Procedure

1. All selected elements are taken out of the sequential function chart.
2. The residual sequential function chart is updated to reflect consistent numbering.
3. The selected elements are then reinserted individually into the residual sequential function chart from bottom right to top left.
4. Every selected element is inserted into the sequential function chart with the sequence number of the topological descendant, increasing the sequence numbers of all topological descendants by one.

Program example

	**Elements E1, E2 and E3 are to be arranged topologically.**
	All selected elements are removed from the sequential function chart. The residual sequential function chart is then updated to reflect consistent numbering.
	The selected elements are then reinserted into the residual sequential function chart individually from bottom right to top left. Element E3 will be inserted first with the sequence number of the topological descendant (E5), increasing the sequence numbers of all topological descendants (E5, E6) by 1.
	Element E2 will be inserted with the sequence number of the topological descendant (E6), increasing the sequence numbers of all topological descendants (E6) by 1.

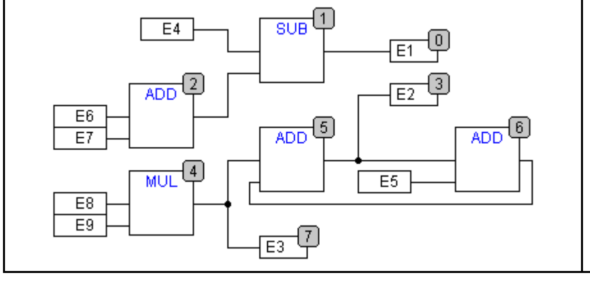
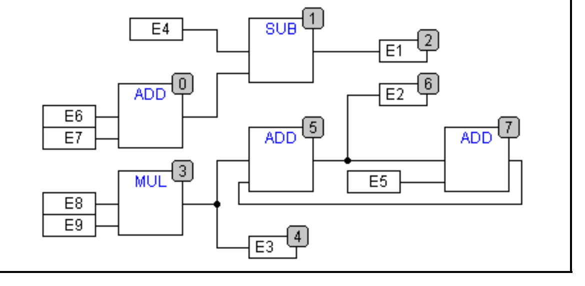
	Element E1 will be inserted with the sequence number of the topological descendant (E2), increasing the sequence numbers of all topological descendants (E2, E6) by 1.
	After command execution, the sample sequential function chart will look like this.

7.7.12.3 Arrange in accordance with the data flow

Icon: -	Menu: **Extras →Order →Arrange in accordance with the data flow**	Keyboard: -

Use this command to arrange all elements in accordance with their data flow in the CFC editor.

- This command is applied to **all** elements.
- The processing sequence is determined by the data flow of the elements, not by their position.

Before command execution:	**After command execution:**
	

7.7.12.4 Bring forward by one

Icon: -	Menu: **Extras→Order→Bring forward by one**	Keyboard: -

Use this command to bring all selected elements forward by one position within the sequential function chart in the CFC editor.

- This does not apply for the elements at the beginning of the sequential function chart.

7.7.12.5 Send back by one

Icon: -	Menu: **Extras→Order→Send back by one**	Keyboard: -

Use this command to send all selected elements back by one position within the sequential function chart in the CFC editor.

- This does not apply for the elements at the end of the sequential function chart.

7.7.12.6 To the beginning

Icon: -	Menu: **Extras→Order→To the beginning**	Keyboard: -

Use this command to bring all selected elements to the beginning of the sequential function chart in the CFC editor.

- The sequence among the selected elements remains unchanged.
- The sequence among the other elements also remains unchanged.

7.7.12.7 To the end

Icon: -	Menu: **Extras→Order→To the end**	Keyboard: -

Use this command to send all selected elements to the end of the sequential function chart in the CFC editor.

- The sequence among the selected elements remains unchanged.
- The sequence among the other elements also remains unchanged.

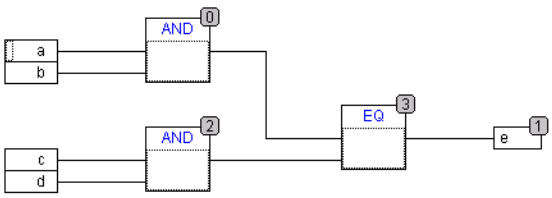
7.7.12.8 Create macro

Icon:	Menu: **Extras→Create Macro**	Keyboard: **<Ctrl>+<I>**

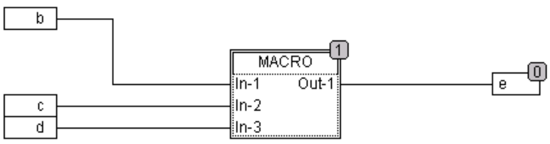
Use this command to group several boxes into one block that can then be named as a macro.

- Macros are duplicated with Copy and Insert. Each copy represents a separate macro that can be freely named. Macros are no references.
- Connections separated by macros create in or out pins at the macro. Connections to inputs create an in pin, for example. The default name appears in the format In-<n> next to the created in pin, and as Out-<n> for outputs.
- Any connections affected that featured connectors prior to macro creation, are assigned the connector the macro PIN.
- Initially, any macro is given the default name *MACRO*. That can be changed.

Three boxes and one input have been selected for the example.



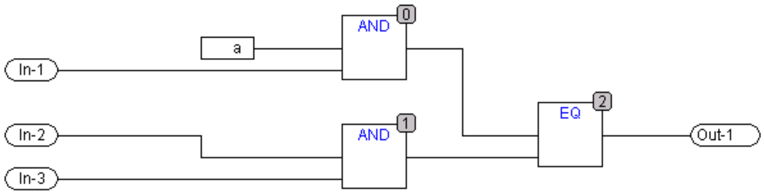
The following macro is created with menu command **Extras→Create macro**. The unit can be shown more efficiently by moving the boxes.



7.7.12.9 Step into macro

Icon: -	Menu: **Extras→Step into macro**	Keyboard: -

Use this menu command or double-click the macro body to open the macro for processing in the editor window.

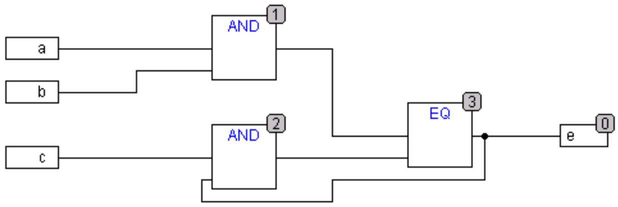


- The created pin boxes can be edited like normal boxes, differing in the representation and containing no position index.
- Pin boxes have rounded edges. The pin box text matches the name of the pin in the macro representation.
- The sequence of pins at the macro box is dependent on the macro element processing sequence.
  – Low-before-high sequence index
  – Top-before-bottom pin
- The processing sequence in the macro is a self-contained procedure. In its higher-level box, the macro is treated as a block. Commands are effective in the macro only.

7.7.12.10 Expand macro

Icon: -	Menu: **Extras→Expand macro**	Keyboard: -

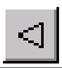
Use this menu command to re-expand the selected macro into its individual elements.



- Connections to in / out pins are represented by element inputs / outputs.
- The unit is moved automatically in cases where the editor does not offer sufficient space for expansion.
- The elements can be returned to efficient positions following expansion.

Note!
All macros are expanded if the project is converted into another language.

7.7.12.11 One Macro Level Back

Icon: 	Menu: **Extras→One Makro Level Back**	Keyboard: -

This command is active when jumping to a macro or the macro is open for processing.

With interleaved macros it is possible to jump back one macrolevel.

7.7.12.12 All Macro Levels Back

Icon:	Menu: **Extras→All Makro Levels Back**	Keyboard: -

This command is active when jumping to a macro or the macro is open for processing.

With interleaved macros it is possible to jump back all macrolevels.

7.7.12.13 Open instance

Icon: -	Menu: **Extras→Open instance**	Keyboard: -

This command is identical to menu item **Project→Open instance.**

7.7.12.14 Zoom

Icon: -	Menu: **Extras→Zoom**	Keyboard: **<Alt>+<Enter>**

Use this command to open the implementation of a selected box.

7.7.13 CFC in online mode

Monitoring

The values for inputs and outputs are displayed within the input or output boxes. Constants are not monitored (visible). For non-Boolean variables, the boxes will be enlarged in accordance with the displayed values. If the value is TRUE, variable names and connection in Boolean connections are highlighted in blue.

Internal Boolean connections are also highlighted in blue in online mode.

Breakpoints

Breakpoints may be set to all elements with a sequential function chart index. Program processing will be halted prior to execution of the respective element. The element's sequential function chart index will be used as the breakpoint position during the breakpoint dialog.

Set breakpoints to a selected element via

- F9
- **Online→Breakpoint on/off**
- the CFC editor shortcut menu

Following repeated execution of menu command **Online→Breakpoint on/off** the breakpoint will be deleted again. The breakpoint can be toggled by double-clicking the element.

Breakpoints are represented under **Project→Options** Category *Colours.*

Return label

In online mode, a jump label with the identifier RETURN is automatically generated in the first column and after the last element in the CFC editor. This label marks the box end and is jumped to during single-stepping prior to exiting the box. No RETURN labels are inserted in macros.

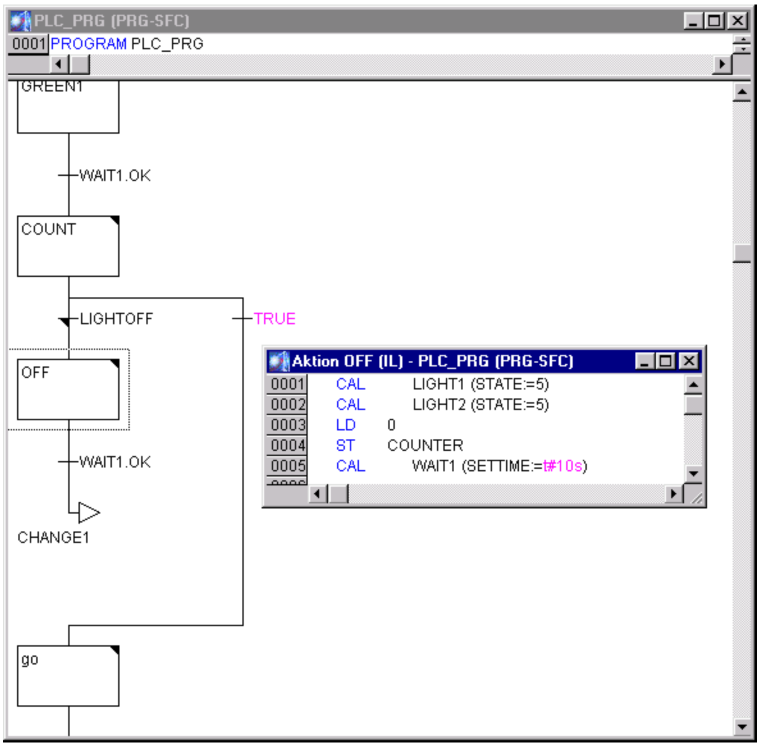
Single-stepping

If the menu command **Online→Single step over** is active, the process will always jump to the element with the higher sequential function chart index.

If the menu command **Online→Single step in** is active, the process will branch into the implementation in the case of a macro or an organization unit.

7.8 SFC editor

The graphic Sequential Function Chart editor describes the chronological sequence of various actions within a program.



Tip!
The most essential commands for the SFC editor are also available in the shortcut menu (right mouse key)
Tool tips display the full names of transitions, actions, etc.

7.8.1 Selecting blocks

A selected block is a set of SFC elements surrounded by a dotted rectangle.

- Elements (steps, transitions, jumps) can be selected with a click or the arrow keys.
- To select a set of several elements, select one and press the **<Shift>** key before selecting the element in the left- or right-hand bottom corner of the set. The resulting set is the smallest contiguous set of elements containing these two elements.

Tip!
Note that all commands must comply with the language conventions to be executed.

7.8.2 Commands in the “Insert” menu

7.8.2.1 Step transition (before)

Icon:	Menu: **Insert→Step transition (before)**	Keyboard: **<Ctrl>+<T>**

Use this command to insert a step followed by a transition before the block selected in the SFC editor.

Tip!

A step followed by a transition can be deleted by selecting step and transition and pressing the **<Del>** key.
(Keep the **<Ctrl>** key depressed to select several objects.)

7.8.2.2 Step transition (after)

Icon:	Menu: **Insert→Step transition (after)**	Keyboard: **<Ctrl>+<E>**

Use this command to insert a step followed by a transition after the first transition in the block selected in the SFC editor.

Tip!

A step followed by a transition can be deleted by selecting step and transition and pressing the **<Del>** key.
(Keep the **<Ctrl>** key depressed to select several objects.)

7.8.2.3 Alternative branch (right)

Icon:	Menu: **Insert→Alternative branch (right)**	Keyboard: **<Ctrl>+<A>**

Use this command to insert an alternative branch as right-oriented branch to the block selected in the SFC editor.

- For this purpose, the selected block must start and end with a transition. The new branch then consists of a transition.

7.8.2.4 Alternative branch (left)

Icon:	Menu: **Insert→Alternative branch (left)**	Keyboard: -

Use this command to insert an alternative branch as left-oriented branch to the block selected in the SFC editor.

- For this purpose, the selected block must start and end with a transition. The new branch then consists of a transition.

7.8.2.5 Parallel branch (right)

Icon:		Menu:	**Insert→Parallel branch (right)**	Keyboard:	**<Ctrl>+<L>**

Use this command to insert a parallel branch as right-oriented branch to the block selected in the SFC editor.

- For this purpose, the selected block must start and end with a step. The new branch then consists of a step.
- To enable jumps to the created parallel branch it must have a jump label.

7.8.2.6 Parallel branch (left)

Icon:		Menu:	**Insert→Parallel branch (left)**	Keyboard:	-

Use this command to insert a parallel branch as left-oriented branch to the block selected in the SFC editor.

- For this purpose, the selected block must start and end with a step. The new branch then consists of a step.
- To enable jumps to the created parallel branch it must have a jump label.

7.8.2.7 Jump

Icon:		Menu:	**Insert→Jump**	Keyboard:	**<Ctrl>+<U>**

Use this command to insert a jump at the end of the branch of the block selected in the SFC editor.

- For this purpose, the branch must be an alternative branch.
- The jump label **Step** must be substituted with the name of the destination step.

7.8.2.8 Transition jump

Icon:		Menu:	**Insert→Transition jump**	Keyboard:	-

Use this command to insert a transition followed by a jump at the end of the branch selected in the SFC editor.

- For this purpose, the branch must be a parallel branch.
- The jump label **Step** must be substituted with the name of the destination step.

7.8.2.9 Add entry action

Icon:	-	Menu:	**Insert→Add entry action**	Keyboard:	-

Use this command to add an entry action to a step.

- An entry action is executed once-only immediately after the step has been activated.
- The entry action can be implemented in any language.
- A step with entry action is identified with an ”E” in the bottom left-hand corner.

7.8.2.10 Add exit action

Icon: -	Menu: **Insert→Add exit action**	Keyboard: -

Use this command to add an exit action to a step.

- An exit action is executed once-only before the step is deactivated.
- The exit action can be implemented in any language.
- A step with exit action is identified with an ”X” in the bottom right-hand corner.

7.8.3 Commands in the “Extras” menu

7.8.3.1 Insert parallel branch (right)

Icon: -	Menu: **Extras→Insert parallel branch (right)**	Keyboard: -

Use this command to insert the contents of the clipboard as right-oriented parallel branch of the selected block.

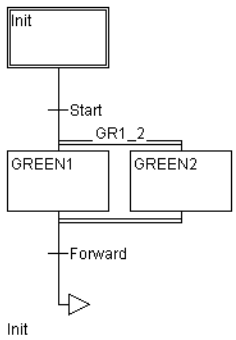
- For this purpose, the selected block must start and end with a step.
- The contents of the clipboard must also be an SFC block starting and ending with a step.

7.8.3.2 Add label to parallel branch

Icon: -	Menu: **Extras→Add label to parallel branch**	Keyboard: -

Where an inserted parallel branch is to be given a jump label, the transition directly before the inserted parallel branch must be selected.

- Execute menu command **Extras→Add label to parallel branch** .
- The name Parallel 1, 2 etc. is assigned and can be edited. In the example the name is GR_1_2.



- Delete a jump label by deleting the jump label text.

7.8.3.3 Insert after

Icon: -	Menu: **Extras→Insert after**	Keyboard: -

Use this command to insert the SFC block in the clipboard after the first step or the first transition of the selected block (a normal ”Copy” inserts it in front of the selected block).

- The command will be executed only if the resulting SFC structure complies with the language conventions.

7.8.3.4 Zoom action/transition

Icon: -	Menu: **Extras→Zoom action/transition**	Keyboard: **<Alt>+<Enter>**

Shortcut: **<Alt>+<Enter>**

The action of the first step of the selected block or the transition body of the first transition of the selected block will be loaded into the editor in the language it was written in.

- If the action or the transition body is empty, select the language it is to be written in.

7.8.3.5 Delete action/transition

Icon: -	Menu: **Extras→Delete action/transition**	Keyboard: -

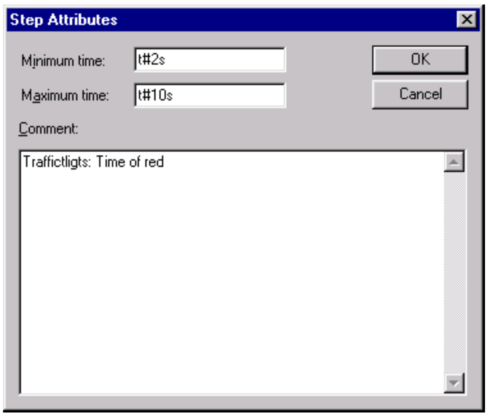
Use this command to delete the actions of the first step of the selected block or the transition body of the first transition of the selected block.

- If either the action, entry action or exit action of a step is implemented, it will be deleted with this command. Otherwise, a dialog box will appear to select the action or actions to be deleted.
- If the cursor is in an IEC step action, only this association will be deleted.
- If an IEC step with an associated action has been selected, the association will be deleted. IF the IEC step has several actions, select an action from the dialog box.

7.8.3.6 Step attributes

Icon: -	Menu: **Extras→Step attributes**	Keyboard: -

Use this command to open a dialog box for the editing of attributes for the selected step.



Three different entries are possible:

- Use the input field *Minimum time* to specify the minimum time for processing this step. (Type **`TIME`**)
  Note: Even if the subsequent transition is **`TRUE`** , the step will remain active for this time.
- Use the input field *Maximum time* to enter the maximum time for processing this step. (Type **`TIME`**)
- Use the input field *Comment* to enter a comment for the step.

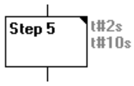
Use **Extras→Options** to set the SFC editor to display comments or time settings for your steps. The comment or time setting will then be displayed to the right of the step.

Tip!

SFC flags will be set to signal that the maximum time has been exceeded. These flags can be interrogated by the user.

The time the step has already been active is displayed in online mode.

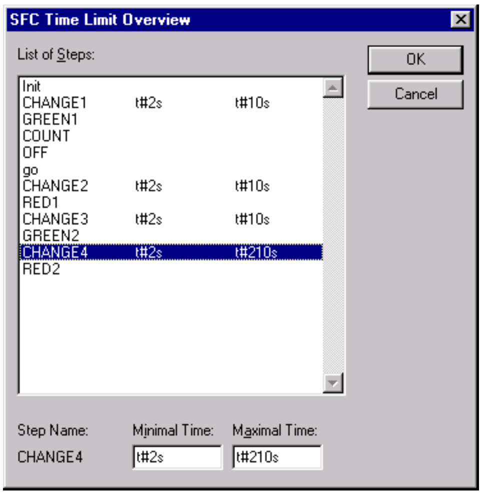
The following example shows a step whose processing is to take a minimum of two and a maximum of ten seconds.



7.8.3.7 Time limit overview

Icon: -	Menu: **Extras→Time limit overview**	Keyboard: -

Use this command to open the dialog box *Time limit overview* to edit the time settings for your SFC steps.



The dialog box *Time limit overview* displays all steps of your SFC organization unit.

If a time limit has been entered for a step, it will be shown to the right of the step (minimum limit first, then maximum limit).

Edit time limits

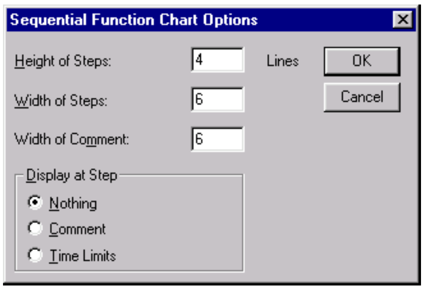
Time limits can be edited:

1. Click the required step in the overview. The step name is displayed at the bottom of the window.
2. Use input fields **Minimal time** / **Maximal time** to specify the required time limit (constant or variable of type `TIME`), e. g. `T#3s`.
3. Click **OK** to close the dialog box and save the changes.

7.8.3.8 Options

Icon: -	Menu: **Extras →Options**	Keyboard: -

Use this command to open a dialog box for the setting of different options for your SFC organization unit.



Height of steps

Use text field **Height of steps** to enter the number of lines for the height of an SFC step in your SFC editor (standard setting: 4).

Width of steps

Use text field **Width of steps** to enter the number of columns for the width of a step (standard setting: 6)

Display at step

Use the option boxes to specify what to display with the step.

- **Nothing**: No display.
- **Comment**: Displays the step comment.
- **Time limit overview**: Displays time limits.

Comments and time limits are displayed as defined under **Extras→Step attributes**.

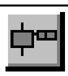
7.8.3.9 Associate action

Icon: -	Menu: **Extras →Associate action**	Keyboard: -

Use this command to associate actions and Boolean variables with IEC steps.

- Another split box is added to the right of the IEC step for the association of an action.
- The left-hand field is pre-assigned with the qualifier `N` and the name `Action`. Both pre-assignments can be changed with the Help Manager **<F2>**.
- New actions for IEC steps for organization units are created in the *Object Organizer* with the command**Project→Add action**.

7.8.3.10 Use IEC steps

Icon: 	Menu: **Extras→Use IEC steps**	Keyboard: -

Use this command to insert IEC steps instead of simplified steps when inserting step transitions and parallel branches.

- If the command is active, a tick appears in front of the menu item and the symbol in the tool bar looks as if it was pressed.
- The init step is generated as an IEC step during the creation of an SFC organization unit.
- Re-execute the command to deactivate it.
- This setting is saved in the ini file and restored on DDS restart.

7.8.4 Commands in the “Project” menu

7.8.4.1 Add action

Icon: -	Menu: **Project →Add action**	Keyboard: -

Use this command to generate an action for the selected SFC organization unit in the *Object Organizer,* that can be used for the IEC steps of this organization unit.

- Select the action name and the language to be used to implement the action from the dialog box displayed after command selection.

The new action will be added under its SFC organization unit in the *Object Organizer,*. and a plus sign will appear in front of the SFC organization unit.

- Click the plus sign to display all action objects. A minus sign will appear in front of the organization unit.
- Click the minus sign to hide the actions again and to return the plus sign.

Tip!

The shortcut menu commands **Expand node** and **Minimize node** can also be used to display or hide the objects.

Double-clicking the action or pressing **<Enter>** loads the action into the editor.

7.8.5 SFC flags

So called SFC flags will be set if a step in SFC is active longer than specified in its attributes.

The user can define more variables to control the sequential function chart.

Before SFC flags can be used they must be declared. The declaration may be global or local, as output or input variable.

SFCEnableLimit

- Variable is of type `BOOL`.
- If this variable is `TRUE` , step timeouts will be registered in `SFCError`. Otherwise, timeouts will be ignored.

SFCInit

- Variable of type `BOOL`.
- If this variable is `TRUE` , the SFC will be reset to the init step and the other SFC flags will be reset, too. The init step remains active but will not be executed as long as the variable is `TRUE` . Only if `SFCInit` is reset to `FALSE` will the organization unit be processed normally again.

SFCReset

This `BOOL` -type variable behaves similarly to `SFCInit`. Here, however, init step processing is continued after initialization. This aspect can be used to reset the `SFCReset` flag in the init step immediately to `FALSE`.

Tip!

`SFCInit` and `SFCReset` cannot be used simultaneously in one organization unit. `SFCInit` will always have priority.

Example of a declaration

```
PROGRAM flags
VAR
 SFCEnableLinit:BOOL;
 SFCError:BOOL;
 SFCErrorStep:STRING;
 SFCReset AT %IX1.0.2: BOOL;
 SFCInit AT %IX1.0.3:BOOL;
END_VAR
```

SFCQuitError

Variable of type **BOOL**.

Processing of the SFC diagram will be suspended as long as this variable is **TRUE** , resetting a potential timeout in variable **SFCError** . Resetting the variable to **FALSE** will reset all previous times in the active steps.

SFCPause

- Variable of type **BOOL**.
- Processing of the SFC diagram will be suspended as long as this variable is **TRUE** .

SFCTrans

- Variable of type **BOOL**.
- This variable is set to **TRUE** if a transition becomes TRUE.

SFCError

- Variable of type **BOOL**.
- This variable will be set if a timeout has occurred in an SFC diagram.

SFCErrorStep

- Variable of type **String**.
- In the event of timeout, this variable saves the name of the step that caused the timeout.

SFCErrorPOU

- Variable of type **String**.
- In the event of a timeout, this variable saves the name of the organization unit in which the timeout occurred.

SFCCurrentStep

- Variable of type **String**.
- This variable saves the name of the active step independently of the time limits.
- In the case of parallel branching, the step will be saved in the branch on the extreme right.

SFCTip, SFCTipMode

These variables of type **BOOL** allow the tip area of SFC. If that is activated by **SFCTipMode= TRUE** , advance to the next step is possible only by setting **SFCTip** to **TRUE**. As long as **SFCTipMode** is set to **TRUE** , advance is also possible via the transitions.

SFCErrorAnalyzation

This variable is of type **STRING**. If the SFC flag **SFCError** registers a timeout, **SFCErrorAnalyzation** will output the responsible variables or transition expressions.
This function requires the library Analyzation.lib to be integrated into the DDS project.

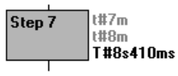
Tip!

If a timeout has occurred and the variable `SFCError` has not been reset, no subsequent timeouts will be registered.

7.8.6 Sequential function chart in online mode

Monitoring

- The SFC editor displays the currently active steps in blue in online mode.
- If several steps are active in a parallel branch, the active step with the action to be processed next is displayed in red.
- With IEC steps, all active actions will be displayed in blue in online mode.
- Select **Extras→Options** and option box **Time limit overview** to display time limits next to the steps.
- A third time is displayed below the minimum and maximum time limits to indicate how long the step has so far been active:



In the above illustration, the step has already been active for 8 seconds and 410 milliseconds. It must be active for at least 7 minutes before the step is exited, however.

Tip!

Monitoring of expressions (e.g. A AND B) in transitions will display the overall transition value only.

Breakpoints

Use **Online→Breakpoint on/off** to set a breakpoint to a step. In an action, the breakpoint can be set to the positions permitted for the applied language.

- Processing will then stop before this step or position is executed.
- Steps or positions to which a breakpoint is set are displayed in light blue.

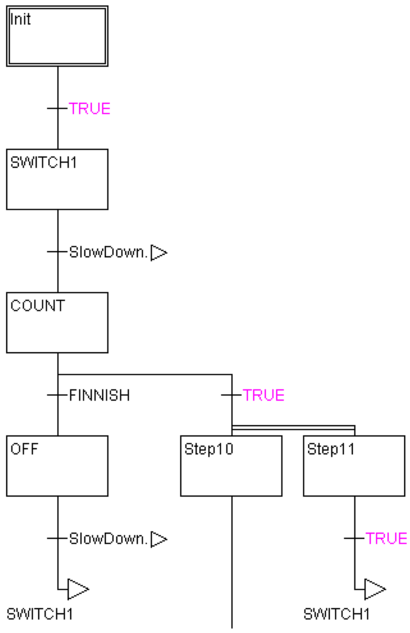
Single step processing

SFC supports single step processing (**Online→Single step over**). The program always advances to the next step with an action to be processed.

If the current position is:

- a step in a linear sequence of an organization unit or a step in the parallel branch at the extreme right of an organization unit, the process exits the SFC organization unit and returns to the invoking unit, starting the next cycle if that is the main program.
- a step in a parallel branch not at the extreme right, the process jumps to the active step in the next parallel branch.
- the last breakpoint position within an action, the process jumps to the unit that called the SFC.
- the last breakpoint position within an IEC action, the process jumps to the unit that called the SFC.
- the last breakpoint position within an entry action or exit action, the process jumps to the first active step.

Use **Online→Single step in** to step into actions. Any entry, exit or IEC action to which a jump is to be effected, must include a breakpoint. All debugging functions of the associated editor are available inside transitions or actions.



Processing sequence of elements in a sequencer.

Tip!

The steps in a sequencer are processed from top to bottom and from left to right.

1. First, all Action Control Block Flags of IEC actions used in this sequencer are reset. The flags of IEC actions that are called within actions remain set.
2. All steps in the sequencer are checked in their sequence in the sequencer as to whether the condition to execute the exit action is fulfilled, and executed if so.
3. All steps are subject to the following procedure:
   – The expired time is copied into the associated step variable.
   – A timeout is checked, and SFC error flags are set accordingly.
   – Only the associated action will be executed if the current step is not an IEC step.
4. The IEC actions of the sequencer are executed in alphabetical order. The list of actions is processed twice, the first run executing all IEC actions deactivated in the current cycle, and the second one executing all IEC actions active in the current cycle.
5. The transitions are evaluated, and the next step is activated, if the following conditions are fulfilled.
   – The step in the current cycle was active.
   – The subsequent transaction is TRUE.
   – The minimum active time has expired.

Implementing actions

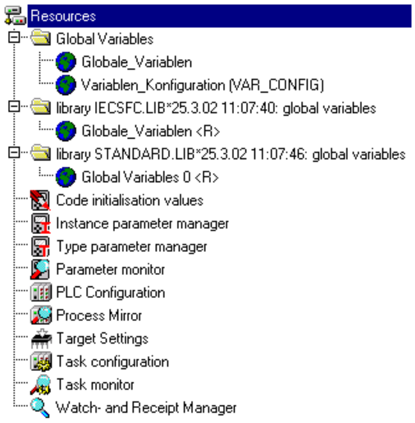
- If an action is associated in several sequencers, it can be executed several times in a cycle.
- Undesirable effects may occur through the above-described processing sequence if the same IEC action is used simultaneously at different SFC levels.
- In such case an error message is output.
- This may occur when processing projects generated with older versions.

Tool tip

Positioning the mouse pointer briefly over a variable in online mode will display a tool tip with the variables's type and any comments.

8 Resources

The tab **Resources** of the *Object Organizer* provides objects for the configuration and organization of your project and for the monitoring of variable values:



Included libraries linked to the project by means of the Library Manager. (📖 8-41)

Global variables of the project and linked libraries. (📖 8-2)

Code initialization values for the initialization of codes with an initial value. (📖 8-4)

Parameter monitor for the parameterization and monitoring of code values. (📖 8-6)

Instance Parameter Manager (📖 8-11)
and
Type Parameter Manager (📖 8-18) **for access to variables via codes.**

Process image for the display of process images of system organization units. (📖 8-20)

PLC configuration for the configuration of your hardware. (📖 8-23)

Task monitor for monitoring the task runtimes. (📖 8-28)

Task configuration for the control of your program via tasks. (📖 8-29)

Watch and Receipt manager for the display and pre-assignment of variable values. (📖 8-35)

Automation system settings for automation system selection and parameterization. (📖 8-38)

Note!
Which of the shown objects are displayed is dependent on the automation system.

8.1 Global variables

The tab card **Resources** in the *Object Organizer* contains the global variable list (Global_Variables) in the folder **Global variables**.

- All variables defined in this object are known throughout the entire project.
- Double-click the object **Global_Variables** to open and edit the variable list.

Global variables

Normal global variables are defined in an object between the keywords **VAR_GLOBAL** and **END_VAR**:

```
VAR_GLOBAL
(* Variable declarations *)
END_VAR
```

Retentive global variables

Retentive global variables are assigned the additional keyword **RETAIN**:

```
VAR_GLOBAL RETAIN
(* Variable declarations *)
END_VAR
```

Global constants

Global constants are assigned the additional keyword **CONSTANT**:

```
VAR_GLOBAL CONSTANT
(* Variable declarations *)
END_VAR
```

Retentive global constants

Retentive global constants are assigned the additional keyword **CONSTANT RETAIN**:

```
VAR_GLOBAL CONSTANT RETAIN
(* Variable declarations *)
END_VAR
```

8.1.1 Several variable lists

If a large number of global variables has been declared, and the global variable list is to be structured better, the setup supports the generation of additional variable lists.

1. Open the *Object Organizer* and select the folder *Global variables* or one of the existing objects with global variables.
2. Execute menu command **Project→Insert object**.
3. Name the object in the dialog box.

This will create a new object with the keyword **VAR_GLOBAL**.

8.1.1.1 All instance paths

Icon: -	Menu: **insert→All instance paths**	Keyboard: -

If the dialog box Variable configuration is open, the following instruction block is created when executing this command:

```
VAR_CONFIG
END_VAR
```

This instruction block includes all instance paths that exist in the project.
In order to obtain existing addresses , declarations available will not be reinserted.
If the project is compiled, the menu item is available again in the window of the variable configuration.

8.1.2 Document template

If a project needs to be documented more than once - with comments in German and English, for example - or to document several similar projects using the same variable names, generate a document template with the help of the menu command **Extras→Create document template**.

Edit document template

The template is an ASCII file that can be loaded into and edited in any text editor.

The template starts with the line `DOKUFILE` followed by a list of project variables.

Every project variable has three lines:

- The first line contains the keyword `VAR` to indicate that a variable starts.
- The second line contains the name of the variable.
- The third line is blank for comments.

Simply delete variables not to be documented from the text. You can create any number of templates for your project.

Use document template

To use a document template, execute menu command **Extras→Select document template**.

- When documenting the entire project or printing parts of it, the comment entered in the template will be inserted in the program text for all variables. This comment is print-only!

8.1.2.1 Create document template

Icon: -	Menu: **Extras→Create document template**	Keyboard: -

Use this command to create a document template.

- The command is available if an object **Global variables** has been selected in the *Object Organizer* on the **Resources** tab.

Selection of the command opens the dialog box *Save as*.

- Enter a new file name in text field **File name**.
- Text field **Save as type** already includes the extension "*.txt".

The now-generated text file lists all variables used within your project.

8.1.2.2 Select document template

Icon: -	Menu: **Extras→Select document template**	Keyboard: -

Use this command to open the dialog box for template selection.

- Select the required document template and click **OK**.

When documenting the entire project or printing parts of it, the comment entered in the template will be inserted in the program text for all variables. This comment is print-only !

8.2 Code initialization values

The code initialization values are an object on tab **Resources** in the *Object Organizer*.

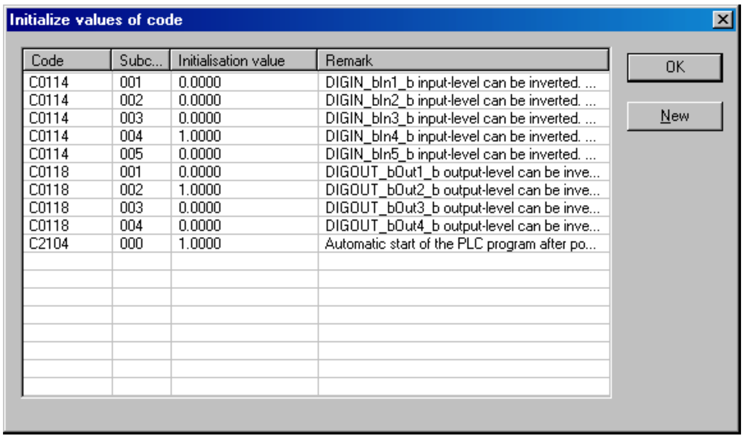
Initialization value priority

Reset modes	Descending priority
Reset	Code initialization value Parameter Manager
Reset (cold)	Code initialization value Parameter Manager
Reset (bootstrap)	Deletes the complete program in the automation system, leaving no value valid.
Program download	Code initialization value Parameter Manager
Mains switching	The last value saved with C0003 is valid.
Load default	Parameter Manager

Use this object to initialize codes with an initial value. Not only the codes generated in the Parameter Manager can be initialized, but also all system codes. These codes are permanently saved in the automation system's parameter set at the end of the download.

- All selected codes are overwritten in the parameter set.
- Any code can be written.
- Overwritten initial values set in the Parameter Manager are only stored in the default setting. (See codes C0002 and C0003)
- The entered codes are saved one after the other in the parameter set.
  Exception: Codes C0086 and C0025 are modified on initialization start as they affect other codes.
- Unknown codes and initialization values beyond the code value limits are ignored by the automation system.

Double-click the object **Code initialization values** in the *Object Organizer* to open the dialog box *Code initialization values*.



Adding code with initial value:

1. In the dialog box *Code initialization value*, click **New** to add a code with initial value.
2. Use the dialog box *Initialize value*, input field **Code** to enter the number of the code (without preceding ”C”) for which an initial value is to be defined.
3. Use input field **Initialize value** to enter a value for code initialization.
4. If the code has subcodes, use input field **Subcode** to enter the associated subcode.
5. Optionally, input field **Remark** can be used to enter a comment to be displayed in dialog box *Code initialization values*.
6. Confirm with **OK** to accept the input, or select **Cancel** to end the process and close the dialog box.

Changing the initial value of a code:

1. In the list box, use the mouse pointer symbol to click on the line with the code to be changed.
2. Use dialog box *Initialize value* to change the values as required, and confirm with **OK**.

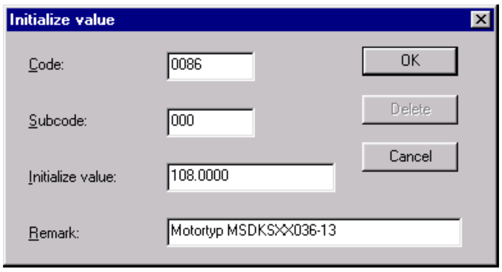
Deleting code with initial value:

1. In the list box, use the mouse pointer symbol to click on the line with the code to be deleted.
2. Use dialog box *Initialize value*, button **Delete** to delete the selected code.

Example:

A project using a **9300 Servo PLC** is to always use the same motor type. To avoid repeated reconfiguration, the motor type can be ”hardwired” in the project with the help of code initialization values.

- 0086 = Motor type selection code
- Initialization value 108 = motor type MDSKSXX036-13, f_N: 200 Hz



8.3 Parameter monitor

The parameter monitor is an object on tab **Resources** in the *Object Organizer.*

Use the parameter monitor to parameterize codes *online* on the PLC. Parameterizable codes include codes created via the Parameter Manager and those of the selected PC (e. g. 9300 Servo PLC, Drive PLC).

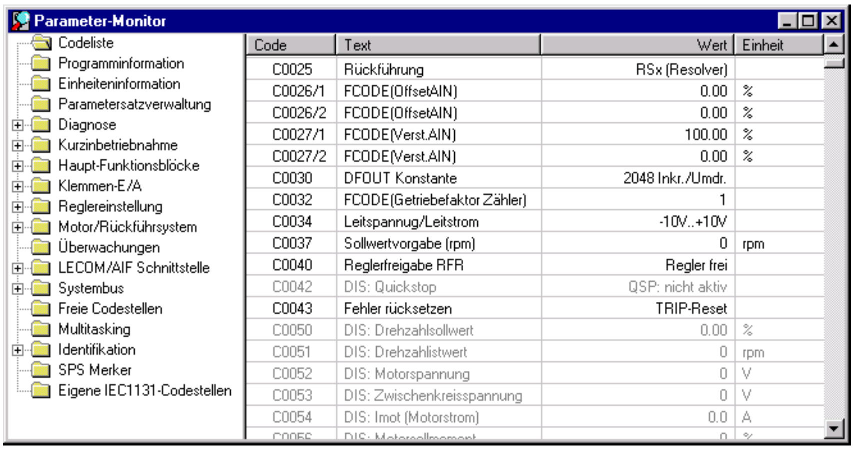
Tip!

No modified code values will be saved in the project after log-out!

To save changes to code values, choose one of the following options.

Open the *Object Organizer* and double-click the object **Parameter monitor** to open the parameter monitor.

- Save the changes in the parameter set of the PLC (C0003=1).
- Save the changes in the project by entering the new values into the object **Code initialization values** in the *Object Organizer.* (📖 8-4)
- Save the changes using the software tool Global Drive Control (GDC).



On its left, the parameter monitor shows a menu tree with folders assigned with codes or further subfolders.

- Folders identified with a plus sign contain subfolders.
  – Click on the plus sign to open the folder and to show the subordinate folders. A minus sign now replaces the plus sign.
  – Click on the minus sign to hide the subfolders.
- Folders without a plus or minus sign do not contain subfolders, but codes.
  – Selecting such a folder will display the codes assigned to the folder on the right-hand side.
  – Read-only codes are shown in grey.
  – Codes whose values have not been read from the PLC yet are shown in green.

8.3.1 System codes/User codes

There are system codes and user codes.

System codes

System codes are default codes "hard-wired" into the PLC and can thus be used to parameterize the PLC with the help of parameterization tools such as GDC or keypad.

- These codes help set the monitor type, the constant of the speed controller, the feedback system, the field bus, the terminal polarity, etc. for the 9300 Servo PLC, for example.
- The parameters for these codes can be set *online* on the PLC with the parameter monitor and saved with C0003=1 in the parameter set of the PLC.

User codes

User codes are created in the Instance Parameter Manager and have a fixed link with a program variable.

- These codes can be used to access variables in the PLC program via field bus profiles, parameterization programs and display and operating tools.

Grouping of codes

- The folder **Code list** contains all codes: The system codes of the selected PLC and the user codes created in the project.
- The folder **Individual IEC 61131 codes** only contains the user codes created in the project.
- All other folders contain system codes of the selected PLC for the parameterization of a specific functionality. The folder **Multitasking** contains all codes that can be used to parameterize the multitasking behaviour of the PLC.

8.3.2 Parameterizing codes

Tip!

For code parameterization via the parameter monitor, the DDS must be connected *online* with the PLC.

- Click the code to be changed to open a dialog box for the modification of the selected code.

8.3.3 Differentiating between online and offline mode

Offline mode

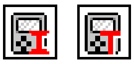
- displays those write code values that were written last by the DDS.
- displays the preset read code values (in general 0).

Online mode

- reads the code values visible in the parameter monitor permanently from the PLC and displays them. Codes whose values have not been read from the PLC yet are shown in green.
- will not save any value changes to write-accessible codes made during a mains off. Only with "Save parameter set" (C0003=1) will the changed values be saved in the PLC's parameter set and made available after mains switching.

The monitoring of variables is restricted while the parameter monitor is open.
Variables may only be updated slowly or not at all.

8.4 Parameter Manager



IEC 61131-3 uses variables to initialize, process and buffer user data. These variables are declared in the declaration part of every POU, i.e. the assignment to a specific data type (byte or integer) is advised. This declaration can be used to define variable properties such as resistance to mains failure, defined initial values or assignments to fixed physical addresses.

Usually, variables are not used in controllers. Controller operation is based on codes. Field bus profiles, parameterization programs, operation and display tools use these codes to process the data stored in the controller.

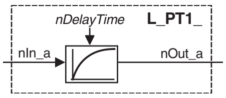
The Parameter Manager of the Drive PLC Developer Studio is a tool for linking codes and variables and accessing variables via codes. User codes and codes of the Lenze function blocks can be managed by means of the Parameter Manager.

Parameter Manager

The user writes his IEC 61131-3 program using the Drive PLC Developer Studio and assigns a code to specific variables to parameterize the program, for diagnostics or to exchange data via fieldbus/system bus in online operation.

- Variables of type **`VAR_IN_OUT`** and variables within a type **`VAR`** function block cannot be assigned codes.

Example: Lenze function block L_PT1_:



VariableName	DataType	SignalType	VariableType
nIn_a	Integer	analog	VAR_INPUT
nOut_a	Integer	analog	VAR_OUTPUT
nDelayTime	-	-	VAR CONSTANT RETAIN

Tip!

Only codes assigned through the Parameter Manager can be displayed and parameterized via GDC, Keypad or parameter monitor in the Drive PLC Developer Studio.

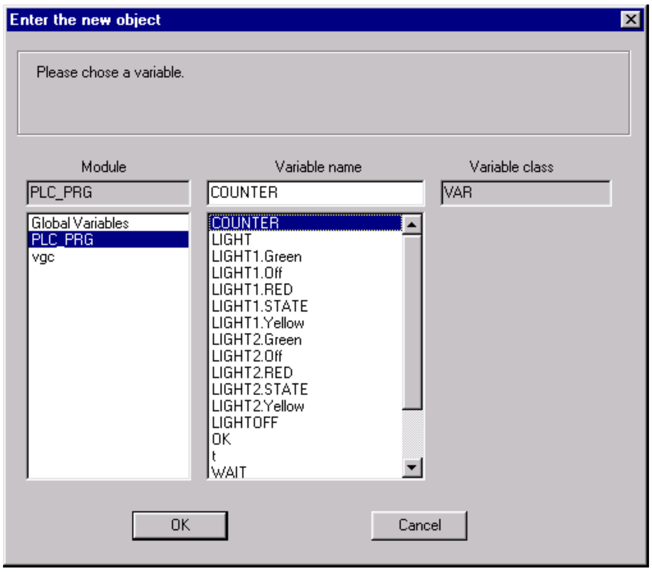
The remaining program structure (variables without code connection) cannot be accessed via the known field bus profiles, parameterization programs, operating and display tools.

If, for example, the user assigns code C6000 to the variable **`nDelayTime`**, the parameterization and diagnostics for the variable **`nDelayTime`** can be performed via this code. Only the codes assigned by the user can be diagnosed/parameterized using the parameterization environment.

8.4.1 Add new object

Icon: -	Menu: **Insert→Add new object**	Keyboard: -

When a new object is created, the name of the organization unit, the variable, the variable type and the variable class are displayed.



8.4.2 Terminology used by the Parameter Manager

Term	Description
User codes	User-specific codes (user codes) can be assigned for variables applied in the user's IEC 61131-3 program. The user codes depend on the automation system and range between C3000 and C7999.
Code properties	Code properties (read only, read/write, direct acceptance or direct acceptance when confirmed, for example) can be defined for each assigned code.
Code value	The code value is the value displayed or entered via the code (using GDC, Keypad or the parameter monitor).This variable corresponds to the physical value known as variable value in the user program (scaling).
Display text	User-specified texts are displayed for parameterization/diagnostics using the Keypad. The text can have up to 13 characters and is displayed for the code.
Input window with yellow background colour	If the user changes a standard setting, the background colour of the field changes to yellow. In such cases, no changes in the Type Parameter Manager for this field will be considered.
Units	Numerical values can also be assigned physical or defined units, such as rpm, Nm, bottles/min, etc.
First instances	When using Lenze function blocks, the instances of these FBs (e.g. of **9300 Servo V2.0**) can be assigned all Lenze parameter codes standard for FBs using the function First instance . Post-editing of the parameter codes is then not possible. The parameter code assignment can be revoked completely. Lenze function blocks can be linked with any codes. Lenze supplies code-parameterized function blocks for standard tasks. For PLC devices, the function blocks are used through linking a library (e.g. LenzeDrive.lib). If the function block (e. g. L_NSET) is to be assigned standard parameterization codes, the function block will be instanced as L_NSET1 of type L_NSET. First instancing The codes, including scaling, for this function block can be created in the Parameter Manager.
Parameterization program languages	GDC or the parameter monitor display every code together with a max. 35 character long text for parameterization/diagnostics. This text can be defined in several languages (standard language/language1/language2) in the Parameter Manager. The language can be selected when the GDC description file is created so that the user decides the language to be used for text displays.
Initialization	An initial value can be assigned to the code to be accepted as initial value in the code's default setting (C0002).
Instance Parameter Manager	Assignment of codes for variables used by the created program POUs or for the global variables of a project.
Scale factor/scale function	Internal variables can be shown more transparently using scale factors. The IEC 61131-3 program uses a 16-bit value (e.g. integer) for example, while the scale function allows a value between ±200% to be set in the GDC. The 16-bit value is simply scaled from ±32767 to ±200. The user can define the limits of the value range in the code, so that the integer value of the code can only be set between ±16384 → ±100%, for example Scale functions allow complex scaling operations. Scale functions are small IEC 61131-3 programs and can be programmed by the user. The program may contain internal conversion scaling operations, limit value calculations, etc.
Subcodes	Subcodes are assigned automatically if the variable is an Array data type. Example: `var1:ARRAY[0..4] OF INT` (up to 5 subcodes assigned) All subcodes are given the same initialization value in the Parameter Manager.
Type Parameter Manager	Definition of a standard setting Predefinition of variables of created function block POUs
Variable types	Variables of type **`VAR_IN_OUT`** and variables within a type **`VAR`** function block cannot be assigned codes.
Variable value	The variable value is the value processed in the IEC 61131-3 program (e. g. integer value of 16384).

8.4.3 Instance Parameter Manager

The Instance Parameter Manager is an object on the tab **Resources** in the *Object Organizer.* It allows the user to assign codes to the variables declared in the project.

- The variables can be declared globally or locally in Program-type POUs.
- Once the Instance Parameter Manager has been started, codes can be assigned for the entire project.

Tip!

The available first instances of a function block are described in the relevant manual for the function library and in the online help, chapter "Lenze function libraries".

8.4.3.1 Opening the Instance Parameter Manager

In the *Object Organizer,* double-click the object **Instance Parameter Manager** to open the Instance Parameter Manager.

Code	Program unit	Variable	Parameter text	Var.Type	Initialize value	Unit	Code max.	Code min.	int.max.
C0672	MotorControl	L_RFG1.dnTif	L_RFG1 Tif (Ablaufz...	DINT	5.000	s	999.999	0.000	999999
C0671	MotorControl	L_RFG1.dnTir	L_RFG1 Tir (Hochla...	DINT	5.000	s	999.999	0.000	999999

- The Instance Parameter Manager displays information on already assigned codes.
- Frequently required commands are also available via the shortcut menu (right mouse key):

Tip!

Use the buttons **Code number** and **Program organization unit** in the top line of the list to define the sorting order for entry display:

- Click **Code number** to sort the entries by ascending code numbers.
- Click **Program organization unit** to sort the entries alphabetically and in ascending order by program organization unit and variable names.

8.4.3.2 Editing codes

Settings for already assigned codes can be edited by

- double-clicking the associated line
  - or -
- selecting the associated line and clicking **Insert→Process the object...**.

This will open the dialog box *Instance Parameter Manager* where the settings for a code can be edited. (📖 8-12)

8.4.3.3 Adding codes

Select **Insert→Add new object** to add a new code.

Note!

It is not permissible to create codes on system variables.

No codes can be created for REAL variables.

- Open the dialog box *Enter the new object* to select the variable to be linked to the code.
- Selection of the variable and confirmation with **OK** will open the dialog box *Instance Parameter Manager* where the settings for a code can be made.

The Instance Parameter Manager supports the following data types.

- BOOL
- BYTE
- SINT
- USINT
- INT
- UINT
- DINT
- UDINT
- WORD
- DWORD

Note!

Copy and insert actions on objects will completely replace the contents.

8.4.3.4 Dialog box Instance Parameter Manager

Open the dialog box *Instance Parameter Manager* to edit the settings for an existing or specify the settings for a new code.

Note!

System variables must not be linked with write/read codes.

Code/index

- The code range from C3000 to C7999 is available. Code numbers are entered without the leading 'C'.
- Clicking the button **First instance** inserts the known parameter code in the input field Code. The input fields **Code max.**/**Code min.** and **Int. max.**/**Int. min.** are greyed out.
- Selecting an existing code will return an error message on clicking **OK**.

Code max./Int. max. and Code min./Int. min.

These four input fields are used to define input limits and to scale the code value.

Use the input fields **Code max./Code min.** to enter the limits the code value will be checked for when written. If the limits are not adhered to during writing, the code value will be rejected by the runtime system.

Together with the values entered in **Int. max./Int. min.**, an assignment is made between code value and scaled variable value used in the program. Scaling uses a line equation whose gradient and zero point are determined by the specified four factors.

The line equation is:

$$m = \frac{int.\ Max. - int.\ Min.}{Codest.\ Max. - Codest.\ Min}$$

$$Variable\ value = m(Code\ value - Code.\ Max.) + Int.\ Max.$$

Example:

- The code limits are to be between ±100%
- The variable limits are to be between ±16384 (integer)
- Calculate the variable value at a set code value of 50%.

$$m = \frac{16384 - (-16384)}{100\% - (-100\%)}$$

$$Variable\ value = m(50\% - 100\%) + 16384 = 8192$$

At a code value of 50% the variable value is 8192. This calculation shows that it is possible to enter an external code value of 50% while calculating internally with the variable value 8192. Thus the value was scaled by 50% to 8192.

Scale function

Scale functions can be inserted for POUs as optional subprograms (IEC 61131-3 program). Such a program can be used to program a complex scaling of a variable with an assigned code. Refer Type Parameter Manager: "Scale functions" (🕮 8-18)

Access

Use the group field **Access** to define whether the code can be read and written or read only.

Initialization

Use the input field **Initialization** to enter the code value to be used to initialize the variable by loading "C0002 = Default setting". The initialization value (code value) is the scaled value, i. e. the initial value is scaled by means of the scale factors before it can be used as variable value in the IEC 61131-3 program.

- The initial value of the Parameter Manager has priority if a variable was initialized with a value in both the declaration editor and the Parameter Manager.

Tip!

Initialization is also possible when no code is assigned.

A variable can be initialized with a scaled value that is transferred on launching the PLC program. The advantage of this is that physical values are used as initial values, for example.

Unit

Use the list field **Unit** to assign a physical or fictitious unit to the code. Use the button **New** to define new application-specific units (e. g. bottles/minute).

Ext. data type

Use the field **Ext. data type** to assign one of the following special data types to a code:

Data type	Decimal code	Length	Polarity
Fixed point*	four fixed decimal positions	32 bit	with
8 bit with polarity	none	8 bit	with
16 bit with polarity	none	16 bit	with
32 bit with polarity	none	32 bit	with
8 bit without polarity	none	8 bit	without
16 bit without polarity	none	16 bit	without
32 bit without polarity	none	32 bit	without
* 1.0000 corresponds to an external specification of 10000, for example. The last four digits are the decimals.			

Display

Use the group field **Display** to define parameterization settings via Keypad.

- Use the input field **Text** to enter display text for the code that will be displayed on the Keypad. The text is limited to 13 characters.
- If the box **Confirmation** is activated, the SHIFT and the PRG key on the Keypad must be pressed at the same time to accept the code value of the respective code. This setting will not be considered for read-only codes.
  – RSP
    Code can only be changed when the controller is inhibited.
  – PLC Stop
    Code can only be changed when the PLC is stopped.

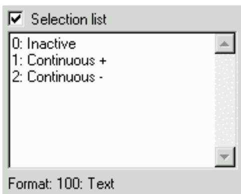
Parameterization program

Use the group field **Parameterization program** to enter code texts for display in GDC and the parameter monitor.

- One of three text options can be selected when generating the device description for GDC.
- These entries are important for the generation of GDC description files in different national languages.

Selection list

Select option **Selection list** to assign freely definable text to code values in the associated text input field:



- These settings will not be considered for read-only codes.
- Complete selection lists are available for the first instances of Lenze function blocks from libraries. These lists can be accepted, extended or modified.
- Selection lists to be accepted by the Instance Parameter Manager can be predefined via the Type Parameter Manager.
- Any predefined lists used will be updated automatically if the original files (libraries, function block POUs) were changed.
- Changes to a predefined list will change its background colour from grey to yellow. Automatic updates will no longer be carried out.
- Only code values defined in the selection list can be addressed via the parameterization environment.

Button "First instance"

Clicking the button **First instance** inserts the known parameter code in the input field Code. The input fields **Code max./Code min.** and **Int. max./Int. min.** are greyed out.

Button "Standard"

Use the button **Standard** to accept the standard settings of the variables.

This means:

- The settings will be accepted for variables set in the Type Parameter Manager, leaving only the code to be assigned.
- The limits of the data type set in the declaration editor will be accepted for variables that are not yet known at this point.

If the user makes any retrospect changes, the background colour of the associated input field changes to yellow to show it is different from the type definition.

Retrospect changes made in the Type Parameter Manager or data type changes in the declaration editor are automatically updated for the associated code.

8.4.3.5 Handling Lenze function blocks

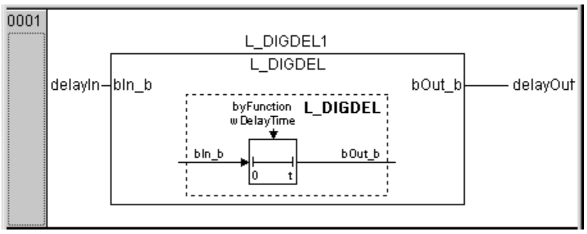
If you use Lenze function blocks in POUs of type Program, `VAR CONSTANT RETAIN` variables of these FBs can be assigned all known parameter codes (e.g. 9300 servo inverter V2.0) using the Parameter Manager. These assignments can of course be revoked again.

Use the correct instance name in the declaration editor of the Program-type POU for this assignment:

- The instance name is the name of the function block followed by a number (1, 2, 3, ...)
- This syntax is valid for all Lenze function blocks.
- If the syntax is changed, only user codes (C3000 - C7999) can be assigned to the instances.

Example of the exact declaration based on function block L_DIGDEL for the 9300 Servo PLC:

If the function block `L_DIGDEL` from the Lenze library **LenzeDrive.lib** is used in a Program-type POU, for example, the FB instance name must be exactly **L_DIGDEL1** (**L_DIGDEL1** of function block type `L_DIGDEL`):



- Only with the correct selection of the FB instance name can the known parameter codes (see table below) of the **9300 Servo PLC** be assigned to the function block by clicking **First instance**.
- Further instances are then named **L_DIGDEL2**, **L_DIGDEL3**, etc.

Note that only **L_DIGDEL1** and**L_DIGDEL2** can be assigned the parameter codes of the **9300 Servo PLC** because this PLC has only two instances of this function block. Further instances (e. g. **L_DIGDEL3**) can only be assigned user codes.

Tip!

The available instances of a function block are described in the online help, chapter "Lenze function libraries".

If variables from Lenze function blocks are linked with codes, setting ranges and scaling operations must be set in accordance with the documentation.

Example: Instances of the function block L_DIGDEL of the 9300 Servo PLC

Variable name	L_DIGDEL1	L_DIGDEL2		Setting range	Lenze
byFunction	C0720			0 ... 2	2
		C0725			0
wDelayTime	C0721	C0726		0.001 ... 60.000 s	1.000

Tip!

Parameter variables can only be read in the PLC program, not written.

Example:

```
LD L_DIGDEL1.byFunction
ST variable_x
```

The **`VAR CONSTANT RETAIN`** variable can only be accessed via the assigned code.

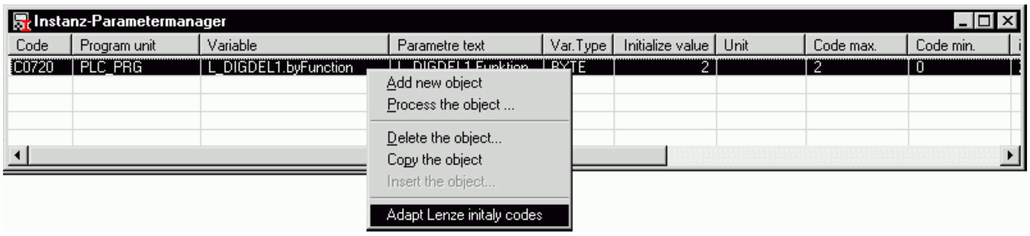
- Use the FB **`L_ParWrite`** from the function library "LenzeDrive.lib" to write codes in PLC programs.

Accepting all Lenze codes of a function block

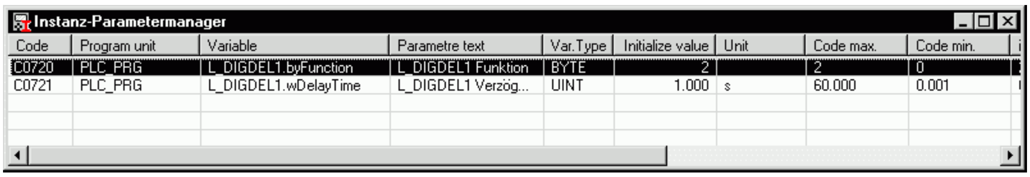
Open the dialog box *Instance Parameter Manager* and click the button **First instance** to assign the associated code only to the selected variable.

To accept all Lenze codes of the function block instance, select a variable of the associated function block in the Instance Parameter Manager and click **Insert→Adapt Lenze initial codes**.

- This command is also available in the shortcut menu:



Command execution creates all codes of the function block instance in the Instance Parameter Manager (in this example: `L_DIGDEL1.wDelayTime`):



8.4.3.6 Accessing arrays via subcodes

Access to individual array fields by means of codes (e. g. using the **Keypad**, for example) is via so-called subcodes.

Subcodes are a code subset of a master code.

Example:

```
C6000        Master code
C6000/1      Subcode 1
C6000/2      Subcode 2
 ... ...
C6000/n      Subcode n
```

Generating subcodes

The Parameter Manager can only assign subcodes to variables of the type `ARRAY OF` Observe the following:

- Only the master code need be defined. The subcodes are generated automatically according to the array length.
- Subcode 1 is always the first element of the array.
- Subcodes are set globally through the master code, i. e. each subcode has the same configuration as the master code. As this also applies to display texts, select a general text to rule out misunderstandings.
- Use the parameter monitor for individual subcode settings. (📖 8-6)

Example: Relationship between field variables and subcodes

Variable in PLC program:	**Assigned code:**
`X: ARRAY [0..4] OF INT`	C6000
Array fields:	**Automatically generated subcodes:**
X[0]	C6000/1
X[1]	C6000/2
X[2]	C6000/3
X[3]	C6000/4
X[4]	C6000/5

8.4.3.7 Data export

Icon: -	Menu: **Extras→CSV export**	Keyboard: -

If the instance parameter manager is active, this menu command can be used to export the contents of the instance parameter manager.

The export file with the name *.csv is saved in the same file folder as the DDS project file with the name *.pro. CSV (comma sequented values) saves the data of the instance parameter manager using the same column pattern. For future processing the file can e.g. be opened with Excel.

Tip!

Do not open the file directly in the Explorer via a double-click, but via the menu command **file→open** in Excel in order to improve configuring of the export file.

8.4.4 Type Parameter Manager

The Type Parameter Manager is an object on the tab **Resources** in the *Object Organizer.*

For the use of libraries or POUs of type Function block in a project, the limits/scaling operations of the variables, among other things, can be predefined using the Type Parameter Manager.

If a function block created in the Type Parameter Manager is called in a Program-type POU, the settings defined in the Type Parameter Manager will be accepted in the Instance Parameter Manager by pressing the button **Standard**.

Tip!

The Type Parameter Manager handles analogously to the Instance Parameter Manager, the only difference being the selection of a function block type instead of a function block instance. For more information on how to use the Type Parameter Manager, refer to the chapters on the Instance Parameter Manager. (📖 8-11)

8.4.5 Scale functions

Codes can be linked with a scale function.

- A scale function is an IEC 61131 program written by the user for the scaling of these parameters/variables.

Scale function for codes with write access

If a code value changes, the value of the linked variable will change too. (Every) code write can launch a user-generated scale function.

- If processing of the associated scale function is to be rejected on write access to a code as a consequence of a condition, the value of variable `g_bScaleFunctionError` in the scale function must be set to `TRUE`.
  The global variable `g_bScaleFunctionError` of type `BOOL` is included in **Standard.lib**

Scale function for codes with read access

Read access to a code with a parameterization tool (e. g. GDC, Keypad or HMI) may launch a user-generated scale function.

- For this purpose, a write must be performed to the associated scaling variable in the scale function.
- The value of the scaling variable is output via the code after linear scaling.
- The scaling variable is a global variable of **Standard.lib** and must be selected according to the data type:

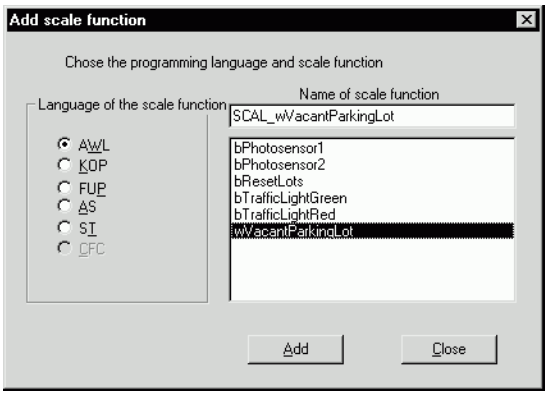
```
g_fScaleFunctionReal  : REAL;
g_fScaleFunctionByte  : BYTE;
g_fScaleFunctionSint  : SINT;
g_fScaleFunctionInt   : INT;
g_fScaleFunctionWord  : WORD;
g_fScaleFunctionDint  : DINT;
g_fScaleFunctionDword : DWORD;
g_fScaleFunctionBool  : BOOL;
```

Example:

- If the display code is assigned to a variable of type `BYTE`, a write must be performed to `g_fScaleFunctionByte` in the associated scale function.

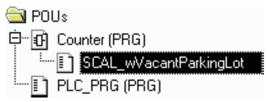
Generating a scale function

1. Open the *Object Organizer*, tab **Organization units** and select the function block you want to assign a scale function to.
2. Select **Project→Add scale function** to open the dialog box *Add scale function.*
3. Open the dialog box *Add scale function* to select the programming language and the associated variable. The name of the scale function will be assigned automatically ("SCAL_" + variable name).



4. Use the button **Add** to add the scale function or **Close** to cancel the process and close the dialog box.

The scale function is inserted underneath the associated FB in the *Object Organizer*. Double-click the scale function in the editor to open and program it.



Using system organization units in scale functions

If a system organization unit is used in a scale function, it must be used in at least one other POU. Otherwise no process image is crea ted for the system organization unit. PLC_PRG or another POU called by a task can be used as a POU, for example.

If system organization units are only used in scale functions or system POUs, no process image is created for them as these organization units are not assigned to any task.
Problems may occur if a system organization unit is used in other tasks, thus leading to the creation of a process image (on PLC_Coldstart, for example).
A warning is given from DDS version 2.0 if system organization units are used in scale functions and system POUs.

Use of scale functions in global function block instances results in a PI trip in the automation system. A compiler error is output from DDS version 2.0 if a scale function is used in a global function block instance.

Note!

Check in the process image monitor that a process image is created for the system organization unit used in the scale function.

8.5 Process image

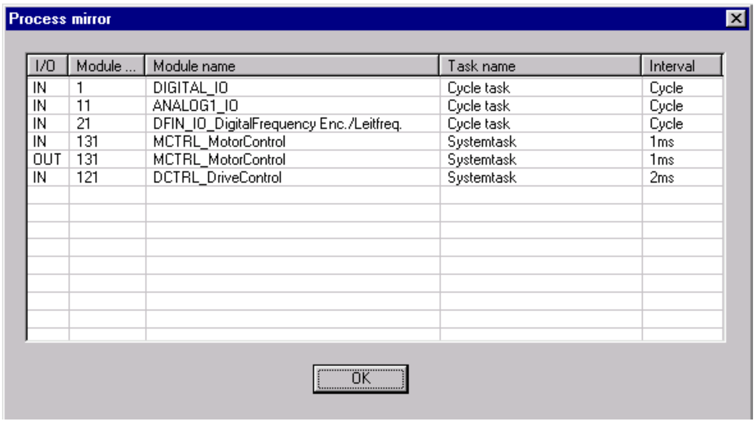
The process image is an object on tab **Resources** in the *Object Organizer.*

- Process images are maps of the statuses of the inputs/outputs of all system organization units used in the automation system at a particular time.

Tip!

- The process image of the Lenze automation systems consists of the I/O statuses of the system organization units entered into the PLC configuration by the user. (Also refer chapter 8.6, “PLC configuration”, 8-23)
- Some system organization units are always processed by the runtime system.
  These system organization units are assigned to a specific (system) task with a fixed time interval.
  (refer associated system organization unit description in the manual for the relevant Lenze automation system.)

- Double-click the object **Process image** in the *Object Organizer* to open the dialog box *Process image*.



I/O	Module ...	Module name	Task name	Interval
IN	1	DIGITAL_IO	Cycle task	Cycle
IN	11	ANALOG1_IO	Cycle task	Cycle
IN	21	DFIN_IO_DigitalFrequency Enc./Leitfreq.	Cycle task	Cycle
IN	131	MCTRL_MotorControl	Systemtask	1ms
OUT	131	MCTRL_MotorControl	Systemtask	1ms
IN	121	DCTRL_DriveControl	Systemtask	2ms

The dialog box *Process image* shows in which task the process image of a system organization unit is generated or written.

Note!

As a consequence of a system organization unit not listed in this dialog box, no process image will be created, and the system organization unit will not be called or processed either!

Dialog box *Process image* provides a shortcut to establishing why the data of a system organization unit are not processed.

A process diagram for the outputs of a system block will only be generated if the outputs are accessed in writing mode.

If the outputs are accessed in reading mode, the action will not appear in the process diagram.

I/O	Display whether inputs (IN) or outputs (OUT) of the system block are concerned.
Module no.	Module number of the associated system organization unit (for module numbers refer associated manual for the automation system or online help, chapter "Lenze automation systems")
Module name	Name of the system organization unit
Task name	Name of the task where the associated process image of a system organization unit is generated or written. • Either the task name selected in the task configuration or the cyclical task or system task (certain system organization units are assigned to the system task). • The system automatically determines the optimized time cycle for the system organization unit.
Interval	This column specifies the time cycle for process image updates.

Tip!

Check before the download whether all applied system organization blocks are listed in the dialog box *Process image* to detect errors quickly.

8.5.1 Generating the process image

The process image consists of

- Process input image = Status of all system organization unit inputs
- Process output image = Status of all system organization unit outputs

Cyclical task (PLC_PRG)

If only one cyclical task is used, the process input image of the system organization units used for this task will be read at the beginning of the cyclical task, and the process output image will be restored at the end of the cyclical task.

- During processing of the automation system program, the status information of the process input image will remain constant, and data consistency is ensured.
- Process image updates depend on the processing time of the cyclical task, in other words, program length and complexity.

Time-controlled task (INTERVAL)

If INTERVAL tasks are used, the process input image of the system organization blocks used for this task will be read at the beginning of the INTERVAL task and the process output image be restored at the end of the INTERVALtask.

- If a certain system organization unit is used in several INTERVAL tasks, the associated process image will be generated in the faster INTERVAL task (independent of whether this system organization unit is also used in the cyclical task).

Tip!

Note that the INTERVAL task may be slower than the cyclical task.

It may be necessary to install a fast task for the process image to ensure that only the process image is updated in time.

Example:

Analog input 1 is used in the cyclical task (runtime: 40 ms) and in an INTERVAL task (runtime: 3 ms).

- The process image for analog input 1 is now updated every 3 ms. The cyclical task receives an updated value every 3 ms during processing (40 ms).

Tip!

Note that data inconsistencies may occur if analog input 1 is used several times within the cyclical task.

- As the process image is updated every 3 ms within the 40 ms of cyclical task processing, there may be different input values for analog input 1.

Event-controlled task (EVENT)

- If system organization units are used in one event-controlled task only, their process image will be generated in the event-controlled task.
- If the same system organization units (that are not also used in a time-controlled task) are used in two event-controlled tasks, their process image will be generated in the cyclical task.

Tip!

For further information about tasks, refer chapter 8.8, “Task configuration”. (📖 8-29)

Interrupt-controlled task

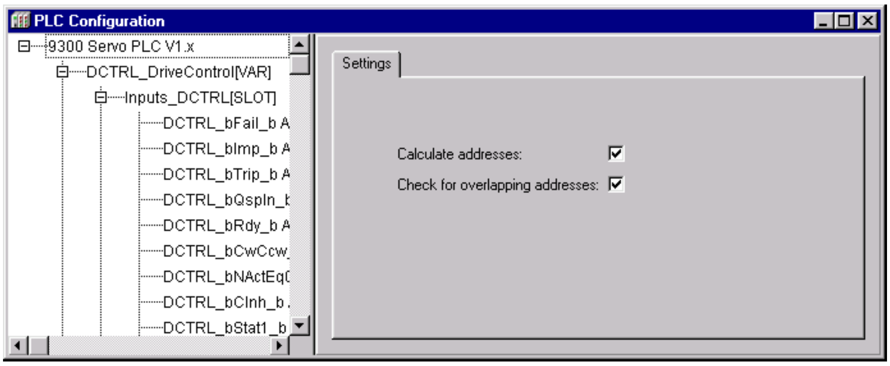
- If system organization units are used in one event-controlled task only, their process image will be generated in the event-controlled task.
- If the same system organization units (that are not also used in a time-controlled task) are used in an event-controlled and an interrupt-controlled task, their process image will be created in the cyclical task.

8.6 PLC configuration

The PLC configuration is an object on tab **Resources** in the *Object Organizer* and combines the resources of the automation system.

The dialog box *PLC Configuration* describes the selected automation system for the project.

The resources of the automation system are described by the applied system organization units. The available system organization units are dependent on the selected automation system.



- The editor displays the configuration as a tree structure that can be edited via menu commands and dialogs.
- In the PLC configuration, the system organization units are attached to the automation system as subordinate elements.
- The editor displays inputs and outputs with an IEC address for input and output access. In standard cases, a symbolic name may be assigned for each input and output for identification, that will then be placed in front of the IEC address.
- Any projects opened that were generated with an older DDS version and containing a PLC configuration, can be transferred into the new **Uniform Control Configuration** format. (🕮 8-25)
- It is important for program generation to insert the required system organization units of the selected Lenze automation system.

System organization units

System organization units are interfaces/organization units permanently integrated into the device (quasi hardware interfaces) that cannot be programmed using the DDS (e. g. MCTRL_MotorControl, DIGITAL_IO, DCTRL_DriveControl, AIF_IO, ANALOG1_IO, ...)

- The DDS checks on the basis of the relevant system organization unit description whether the IEC addresses applied in the program do indeed exist in the automation system.

The system organization units in the PLC configuration consist of several elements that are either inputs or outputs.

- Every input/output has a symbolic name (identifier) that can be changed if necessary and is assigned an IEC address. Thus every input/output can be addressed directly (e. g. %IX1.0.1) or via system variables (DIGIN_bIn1_b) in the program.

8.6.1 Working in the PLC configuration

The configuration editor consists of two window panes.

The left-hand window pane provides a structured representation of the module inputs and outputs. If an organization unit is selected, the data are shown in the right-hand window pane under basic parameters.

The top level of the dialog box *PLC configuration* includes the name of the selected automation system.

Elements identified with a plus sign are organization elements and contain subelements.

- Click the plus sign to show the subelements. Click the minus sign to hide the subelements again.
- Double-click an element to change the input/output variable names.

The variables/direct addresses of the system organization unit inputs/outputs can now be called as system variables in the POUs for programming.

Tip!

The most essential commands for the dialog box *PLC configuration* are also available in the shortcut menu (right mouse key) or via **<Umschalt>→<F10>**.

PLC configuration in online mode

Note!

Only if the automation system is operating does the PLC configuration display the statuses of the control inputs and outputs in online mode.

- If a Boolean input or output has a value `TRUE`, the small box in front of the input or output will be shown in blue.
- Variable values will be displayed with their current value.

Boolean inputs can be toggled by mouse click, other inputs are displayed a dialog box where a new value can be entered. The new value will be set in the control immediately after its confirmation with **OK**.

8.6.1.1 Properties

Icon: -	Menu: **Extras →Properties**	Keyboard: -

Use this command to open a dialog box to save more information (such as a comment, for example) with the input/output module selected in the PLC configuration.

8.6.1.2 Insert element

Icon: -	Menu: **Insert→Insert element**	Keyboard: -

Use this command to insert the selected element into the PLC configuration in front of the highlighted element.

8.6.1.3 Add subelement

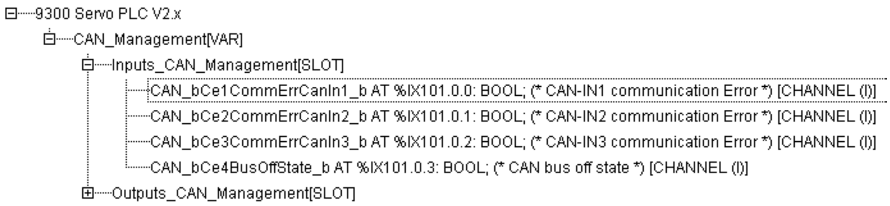
Icon: -	Menu: **Insert→Add subelement**	Keyboard: -

Use this command to insert the selected element into the PLC configuration as the last subelement to the highlighted element.

8.6.1.4 Replace element

Icon:	-	Menu:	**Extras→Replace element**	Keyboard:	-

A correctly defined configuration file allows an element selected in the configuration tree to be replaced with another. This also includes the switching of channels so that they can be used with the configuration as input or output.



8.6.1.5 Calculate addresses

Icon:	-	Menu:	**Extras→Calculate addresses**	Keyboard:	-

Note!

Not all automation systems support this function.

Execution of this menu item requires the check box **Calculate addresses** to be selected in the general PLC configuration settings.

Calculate addresses applies from the selected module and includes all of the elements below.

8.6.1.6 Default configuration

Icon:	-	Menu:	**Extras→Default configuration**	Keyboard:	-

Use this command to delete the set configuration and to return to the original configuration.

8.6.1.7 Convert old PLC configurations

Icon:	-	Menu:	**Extras→Convert**	Keyboard:	-

Use this command to convert any project opened that includes a PLC configuration generated with an older DDS version into the format of the current PLC configuration.

Convert the older project only if you require, and want to use, the functions of DDS 2.x.

Note!

The old configuration cannot be restored.

8.6.2 Touch probe interface

Some automation systems allow the use of digital inputs optionally as touch probe input or simple digital input.

Inputs are configured via the PLC configuration in the DDS.

Note!

The source for the last scan value can be configured via the field Registerparameter.

Observe the following when using digital inputs as touch probe.

- If a digital input is used as a touch probe it can not be used to start a task.
- Every touch probe input is assigned a task to reduce the number of interrupt tasks available for the application.

8.6.3 Configuring an I/O module

Once an I/O module has been selected in the configuration tree, the system displays the dialog box *Basic parameters* with the following options:

Module ID

This is an unequivocal module identifier within the entire configuration environment, taken from the configuration file and cannot be edited.

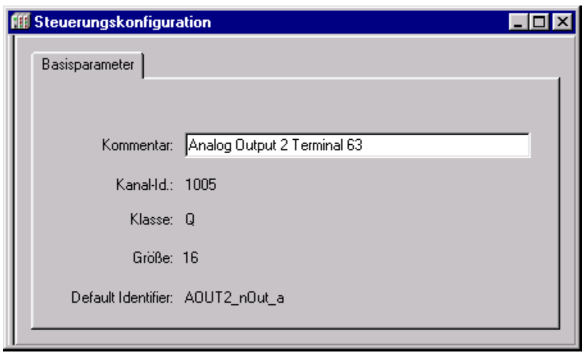
Node number

The node number results from an entry in the configuration file. If there is no entry there, it is sourced from the position within the configuration tree.

8.6.4 Configuring a channel

Basic parameters of a channel

Once a channel has been selected in the configuration tree, the system displays the dialog box *Basic parameters*.



Comment

Additional channel-specific information. The text field allows a comment to be edited or a new one to be entered.

Channel ID

Globally unique channel ID.

Class

Information on channel application

I	Input
Q	Output
I&Q	Input and output
I|Q	Input or output (can be toggled)

Size

Channel range size

Default identifier

Symbolic channel name assigned in the configuration file. The channel name is assigned into the configuration file and can be edited in the configuration tree.

Channel parameters

This dialog box, analogous to the dialog box Module parameters, allows the channel parameter values to be displayed and modified.

As for the modules, it may be substituted with an application-specific dialog box *Custom parameters* .

Bit channels

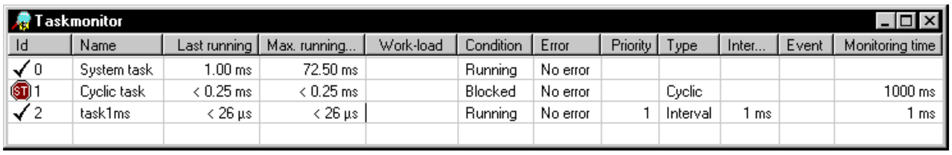
The basic parameters of bit channels only feature the input field **Comment**.

8.7 Task monitor

The task monitor is an object on the tab **Resources** in the *Object Organizer*.

If the PC is connected online with an automation system, the runtime of the individual tasks can be diagnosed via the task monitor. In offline mode, the task monitor displays the last online task status.

- Open the *Object Organizer* and double-click the object **Task monitor** to open the task monitor:



Id	Name	Last running	Max. running...	Work-load	Condition	Error	Priority	Type	Inter...	Event	Monitoring time
✓ 0	System task	1.00 ms	72.50 ms		Running	No error					
ST 1	Cyclic task	< 0.25 ms	< 0.25 ms		Blocked	No error		Cyclic			1000 ms
✓ 2	task1ms	< 26 µs	< 26 µs		Running	No error	1	Interval	1 ms		1 ms

The tasks are displayed in lines along with the following information:

Column	Display
Id	Id of the task (0 ... 9) as well as the status of the task: ✓ = Task is ready or running ST = Task is blocked or inhibited
Name	Task name
Last runtime	Runtime of the last task processing run.
Maximum runtime	Maximum runtime during program operation
Load	Bar graphs with the currently detected task time of an interval task • Green bars: The current task time is less than 80 % of the interval time. • Red bars: The current task time is greater than 80 % of the interval time. • The column width represents 100 % of the interval time. • The black line indicates the maximum task runtime (peak hold) during program operation. • In offline mode, this time is displayed as a figure in percent of the interval time.
Status	Task status (running, inhibited or interrupted).
Error	"Overflow": The task needs more time than the set watchdog time. "No error": The task is processed within the specified watchdog time.
Priority	Task priority
Type	Task type (interval, cyclical, event or interrupt).
Interval	Interval time of an interval task.
Event	Event of an event or interrupt task
Watchdog time	Task watchdog time

Tip!

The displayed task runtimes are not the net times but the real runtimes including all task interruptions at a 25.6 µs resolution.

Cyclical task/system task

- The system task processes any necessary internal system tasks in the background.
- The cyclical task does not only contain the task `PLC_PRG`, but also the task of communicating with the PC.
- System and cyclical tasks apply the time slicing principle to share the low-priority cyclically processing task.

8.8 Task configuration

The task configuration is an object on the tab **Resources** in the *Object Organizer.*

8.8.1 Task definition

IEC 61131-3 refers to a group of PROGRAM-type POUs as a ”task”. POUs are software units used to organize the project (POU = **P**rogram **O**rganization **U**nit).

The task is executed by the runtime system and the program/s included in it ensure the required functionality of the runtime system.

Task types

Lenze automation systems, for example **9300 Servo PLC**, **Drive PLC**, support four different task types:

- **Cyclical task** (`PLC_PRG`)
  `PLC_PRG` is the main loop of the user program (number: 1).
  It is always active, has the lowest priority and cannot be switched off.
  `PLC_PRG` can be created in the required programming language, and other program POUs can be called from `PLC_PRG`
  The use of `PLC_PRG` is not absolutely necessary for a control program.
  The runtime of `PLC_PRG` is not equidistant, i.e. it depends on the program size and the current processor load.
- **Time-controlled task (INTERVAL)**
  Set up time-controlled tasks that can be started periodically.
  The period duration can be set in 1 ms steps between 1 ms and 16 s.
- **Event-controlled task (EVENT)**
  Set up event-controlled tasks to be started through a “Boolean change” of a definable variable or a hardware input of the PLC. The variable can be a global variable or a system variable.
  Response time = 1 ms.
- **Interrupt task**
  This task can be started through a real hardware interrupt (digital input). This interrupt is not triggered via the IEC 61131-3 program, but via the processor. The advantage is that the task can be started very quickly.
  Typical response time = 100 µs; “Worst case” response time = 250 µs.

The number of tasks (time-controlled, event-controlled or interrupt) is dependent on the selected automation system.

Note!

The runtime system monitors the processing time of all tasks.

If processing takes too long or is interrupted frequently by higher-priority tasks, thus extending the processing time beyond the cycle time of a task, for example, a system error will occur and crash the runtime system.

Task properties are set through the DDS in adherence to the following conditions:

Event-controlled task (Interrupt/EVENT)

With an event-controlled task, the Boolean status of the associated variable or the hardware interrupt must change from `FALSE` to `TRUE`) to start this task.

- The initial status `TRUE` of the variable does not start the task!

Saving a start event

If an EVENT-type task is called again during processing, the new call is saved and restarted immediately after the task cycle of the event-controlled task is complete. Only one call can be buffered.

PRIORITY

Every user task (not the **Cyclical task**) has a defined priority between 0 and n
(0 = task never starts; 1 = highest priority ...n-1 = second-lowest priority ...n = lowest priority).

- A priority cannot be assigned twice. It is thus not possible to have two tasks with the same priority.
- The priority of a task can **not** be changed while the automation system runs in online mode.
- The priority of a task decides whether another currently processed task will be interrupted or not. If a lower-priority task is started while a task is running, the lower-priority task will wait and not interrupt the running task.

8.8.2 Data consistency

Multitasking operating systems or, in general, all software structures featuring “concurrent” processes running at different cycle times, have a problem with data inconsistency, which we will briefly look into at this point.

When do data inconsistencies occur?

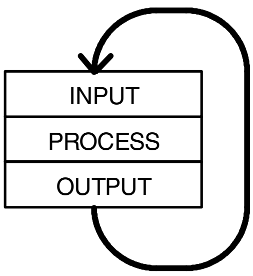
- Variable A is used in different places within routine 1. At routine 1 runtime, variable A is changed by a routine 2.
- A data record consists of 4 variables that must be checked out from the memory for reading. An Interrupt-Service-Routine 2 changes this data record during the read access.

8.8.3 Normal data processing/IPO principle

Normal data processing for simple PLC systems, for example, always follows the IPO principle (input/processing/output) where the data inconsistency problem does **not** occur!

The IPO principle deals with only one data processing branch:

- All data required are read at the beginning of the loop.
- In the middle of the loop, the data are processed and the output values calculated.
- The data are output at the end of the loop (just before the ”loopback”).



With this method, the input data are the same and constant during the entire processing time until the new read at the beginning of the loop. Since there are no further processes that interrupt the IPO process during the runtime of the loop and may access data of the running process, there is no reason for data to become inconsistent !

8.8.4 If a task overflow leads to a system error

If, for instance, a continuous loop or too much program content has been programmed for a task and the task cannot process the program within the specified interval time, a system error will occur in the automation system.

System errors can also occur when a running task is interrupted so frequently by other tasks that the program cannot be processed within the specified task runtime.

A system error trips the automation system.

- The response of motor control and digital outputs can be set under **Project→Exception handling**.
(also refer associated system organization unit description in the manual for the respective Lenze automation system.)
- The program can only be restarted after a TRIP reset or mains switching.

A TRIP reset (Keypad: STOP→RUN key; GDC: Code C0043) resets the Lenze automation system after a task overflow, and the error message “Task overflow” is acknowledged.The automation system must be corrected to prevent further task overflows.

The watchdog time is set as follows:

- Use the task dialog box Properties, input field **Watchdog time** to enter the maximum runtime for the task.
- Interval: The watchdog time is between 0-100 % of the interval time (default=90 %) and can be set between 1 ms and 300 ms.
(With a 1 ms task, the watchdog time is 1 ms = 100 % fixed.)
- Event/Interrupt: The watchdog time can only be set less than 300 ms (default=100 ms).
- Use the dialog box *Exception handling* (**Project→Exception handling**), input field **Watchdog time** to enter the maximum runtime for the cyclical task (`PLC_PRG`).

Tripping the watchdog time

- Tripping the watchdog time activates an error message in the PLC.
- This error message is displayed on the Keypad/in GDC in code C0168.
- After TRIP reset, error message and PLC program will be reset. Use the DDS start command or C2108=1 to restart the program.

8.8.5 Task declaration

A task declaration consists of the task name, the entry for task priority and the condition for its execution.

The condition can be a time interval (1 ms to 16 s) after which the task is to be executed, an event (rising edge at the digital input or `FALSE`/`TRUE` change of a global variable) or a hardware interrupt.

Every task can now be assigned a list of programs (Program-type POUs) to be called by the task. These programs are processed in the listed order.

Tip!

The task settings (properties) cannot be changed in online mode!

Which task is processed?

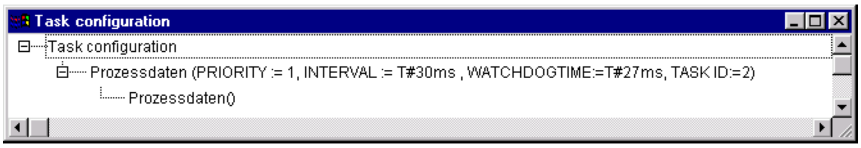
Processing is subject to the following rules:

- The task with the satisfied start condition is executed, when the specified interval time has expired or the addressed variable, in event-control, changes from **`FALSE`** to **`TRUE`**, for example.
- If several tasks have a valid start condition, the task with the highest priority will be executed.
- Tasks cannot share the same priority (limited multi-tasking)
  Exception: Priority 0 = Task inhibited.
- If the start condition of a higher-priority task is satisfied while another task is being processed, the lower-priority task will be interrupted and continued after the higher-priority task has been processed.

8.8.6 Working in the task configuration

The task configuration is an object on the tab **Resources** in the *Object Organizer.*

Double-click the object **Task configuration** in the *Object Organizer* to display the current task configuration in the task editor in the right-hand window pane.



Structure of the task configuration

The task configuration is structured like a directory tree:

- The text "Task configuration" appears at the highest hierarchical level.
- One level below includes a sequence of task entries (name, priority, interval/event, watchdog time, task ID).
- Each task entry in turn contains a sequence of program calls.
- A plus sign in front of the entry indicates that this entry contains subentries that can be shown by clicking the plus sign. Click the minus sign to hide the subentries again.
- Select **Insert→Insert task** to insert a task above the selected task.
- Select **Insert→Add task** to add a task to the end of the existing list when the highest level ("Task configuration") was selected.
- Select **Insert→Insert program call** to add a program call to the selected task. If several programs are added to the task, these POUs will be processed one after the other.
- Select **Extras→Edit entry** to edit the task properties or program call in accordance with the selected element.
- Click a task or program name or press the **<Space bar>** to draw an editing frame around the name. The name can then be changed directly in the task editor.

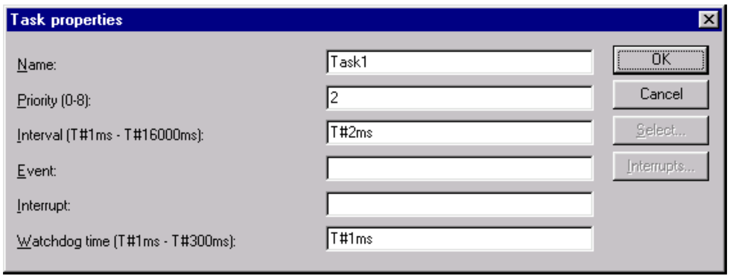
8.8.6.1 Insert task / Add task

Icon:		Menu:		Keyboard:	
	-		**Insert→Insert task**		-
	-		**Insert→Add task**		-

Use this command to insert a new task to the task configuration.

- If a task has been selected, the command **Insert task** is available and inserts the new task in front of the cursor.
- If "Task configuration" is selected, the command **Add task** is available and adds a new task to the end of the existing list.

Selection of one of the two commands opens the dialog box *Task properties* where the required attributes can be entered.



- **Name** of the task (max. 40 characters)
- **Priority** of the task
  (number between 0 and n; 0 = task inhibited, 1 = highest priority, n = lowest priority)
- **Interval** after which the task is to be restarted.
- **Event** (variable which is to effect task execution after a rising edge)
  To select the event from the declared variables, click **Select...** to open the Help Manager.
- **Interrupt**
  To select a real interrupt, click the button **Interrupts...** .
- **Watchdog time** of the task

If

- no entry was made in text fields **Interrupt, Interval** and **Event**,
- the specified interval time or priority is wrong,
- the specified priority already exists,

the **OK** button will remain greyed out.

8.8.6.2 Insert program call / Add program call

Icon: - -	Menu: **Insert→Insert program call** **Insert→Add program call**	Keyboard: - -

Use this command to open the dialog box and enter a program call for a task in the task configuration.

Select **Insert program call** to insert the new program call in front of the cursor and **Add program call** to add the program call to the end of the existing list.

Use the input field **Program call** to enter a valid program name, or press **...** to open the Help Manager for a selection of valid program names.

If the selected program requires input variables, enter these as shown in the example:

Example of input variable:

prg(invar:=17)

8.8.6.3 Properties

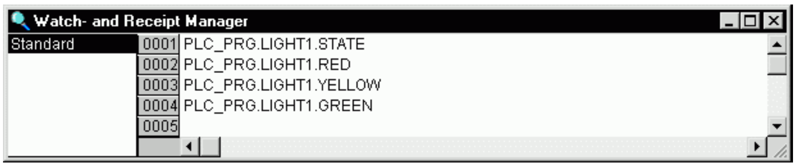
Icon: -	Menu: **Extras →Properties**	Keyboard: **<Enter>**

Depending on the selected element, use this command to open the dialog box *Task properties* or the dialog box *Program call in the task configuration*.

- If the cursor is positioned over a task entry to which no list of program calls has been added yet, open the dialog box Task properties by double-clicking the entry or pressing **<Enter>**.
- If the cursor is positioned over an entry for a program call, double-click the entry to open the dialog box *Program entry*
- Click a task or program name or press the **<Space bar>** to draw an editing frame around the name. The name can then be changed directly in the task editor.

8.9 Watch and Receipt Manager

The Watch and Receipt Manager is an object on the tab **Resources** in the *Object Organizer.*



Use the Watch and Receipt Manager to

- display values of certain variables.
- pre-assign variables with certain values and transfer them to the control in one go.
- read and save current control values as pre-assignment in the Watch and Receipt Manager.

These functions assist in the generation and logging of control parameters, for example.

- The left-hand panel of the Watch and Receipt Manager displays all generated watch lists that can be selected with a click or using the arrow keys.
- The right-hand pane of the Watch and Receipt Manager displays the associated variables.

8.9.1 Watch and Receipt Manager in offline mode

In offline mode, it is possible to create several watch lists in the Watch and Receipt Manager using **Insert→ New watch list** .

The variables to be watched can be selected from a list of all variables called with the Help Manager or entered via the keyboard in accordance with the following notation:

```
<Organization unit name>.<Variable name>
```

- Global variables do not have an organization unit name, but start with a period. The variable name can be multi-level.
- Addresses can be entered directly.

Example of a multi-level variable:

```
PLC_PRG.Instance1.Instance2.Structure.Component name
```

Example of a global variable:

```
.global1.component1
```

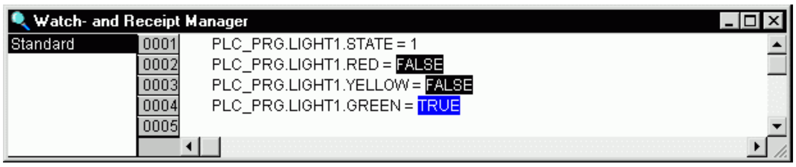
Variables in the watch list can be pre-assigned constant values, i.e. in online mode, these values can be written to the variables using the menu command **Extras→Write receipt**. For this purpose, the constant value must be assigned to the variable with `:=`.

Example:

```
PLC_PRG.TIMER:=50
```

8.9.2 Watch and Receipt Manager in online mode

In online mode, the Watch and Receipt Manager displays the values of the entered variables.



- Structured values (arrays, structures and instances of function blocks) are identified with a plus sign in front of the identifier.
  Click on the plus sign to open the variable. A minus sign appears instead of the plus sign.
  Click on the minus sign to close the variable again.
- If a function block variable is selected in the watch list, the associated shortcut menu is extended by the two menu items **Open function block** and **Open instance** .
- To enter new variables, switch the display off using the command **Extras→Monitoring active**. After the variables have been entered, the display can be activated again with the same command.
- If constant values were assigned to variables in offline mode, these values can be written to the variables using the command **Extras→Write receipt**.
- **Extras→Read receipt** replaces the pre-assignment of a variable with the current variable value.

8.9.3 Command overview

8.9.3.1 New watch list

Icon: -	Menu: **Insert→New watch list**	Keyboard: -

Use this command to insert a new watch list in the Watch and Receipt Manager.

- Enter the required name of the watch list into the dialog box.

8.9.3.2 Rename watch list

Icon: -	Menu: **Extras→Rename watch list**	Keyboard: -

Use this command to change the name of a watch list in the Watch and Receipt Manager.

- Enter the new name of the watch list into the dialog box.

8.9.3.3 Save watch list

Icon: -	Menu: **Extras→Save watch list**	Keyboard: -

Use this command to save a watch list.

Selection of the command opens the dialog box *Save as*.

- Use the input field **File name** to enter a new file name.
- The extension ”*.wtc” is already specified in the input field **Save as type**.

The saved watch list can be reloaded with **Extras→Load watch list**

8.9.3.4 Load watch list

Icon: -	Menu: **Extras→Load watch list**	Keyboard: -

Use this command to load a saved watch list.

Selection of the command opens the dialog box *Open*.

- Select the required file with the extension "*.wtc" and click **OK**.

Enter the new watch list name in the dialog box.

- The input field already displays the file name without extension.

Click **Extras→Save watch list** to save a watch list.

8.9.3.5 Monitoring active

Icon: -	Menu: **Extras→Monitoring active**	Keyboard: -

Use this command to switch the display of the Watch and Receipt Manager on and off in online mode.

- If the display is activated, a tick appears in front of the menu item.

The display must be switched off with this command to enter a new variable or to pre-assign a value. The display can be switched on again after the variable has been entered, executing the command again.

8.9.3.6 Write receipt

Icon: -	Menu: **Extras→Write Receipt**	Keyboard: -

Use this command to write the pre-assigned values to the variables in the Watch and Receipt Manager's online mode.

8.9.3.7 Read Receipt

Icon: -	Menu: **Extras→Read Receipt**	Keyboard: -

Use this command to replace the pre-assignment of the variables with the current values in the Watch and Receipt Manager's online mode.

Example:

```
PLC_PRG.counter [:= <current value>] = <current value>
```

Tip!

Only the values in the watch list selected in the Watch and Receipt Manager will be loaded!

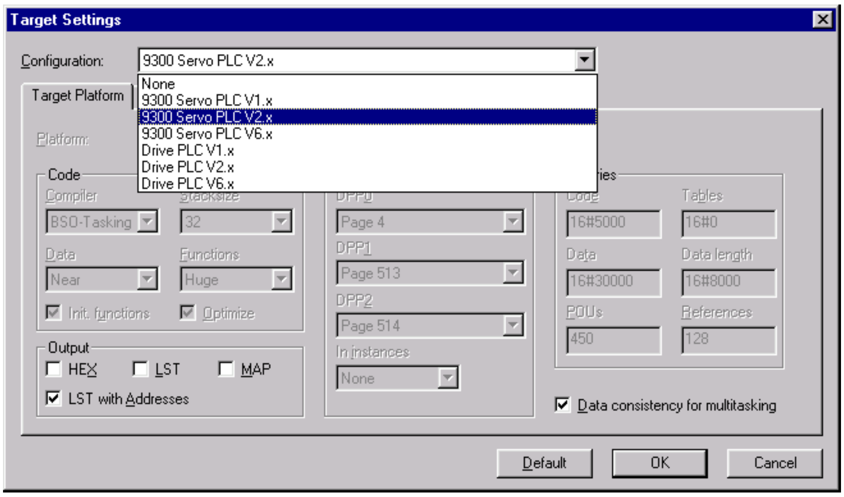
8.10 Target Settings

The Target Settings are located as an object in the Resources index and

- define the target system on which the project is to run,
- define the project settings,
- require a target system to be selected after the menu command **Project→New** has been executed.

The dialog box Target Settings opens automatically when a new project is generated and can also be requested from **Resources→Target Settings**.

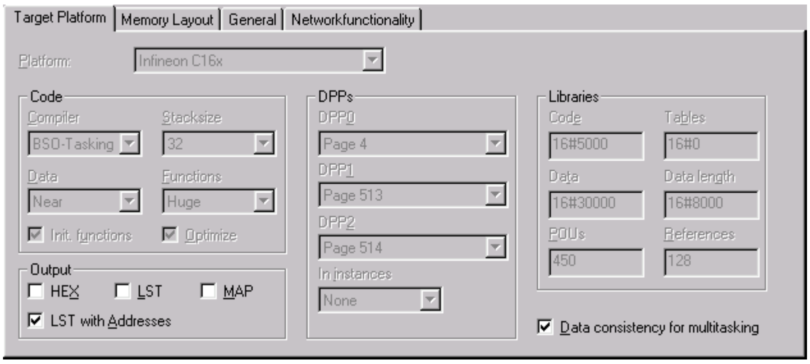
Select a target system from the **Configuration** pull-down menu.



Tip!

The **Default** button resets all entries in this dialog box to the initial state.

Target Platform



On this index card, only the **Output** field is active.

The **Output** field is used to configure the files to be created with the DDS.

Note!

The file types *.HEX, *.LST, *.MAP may only be activated after request by the Lenze support. They are exclusively used for diagnostic purposes.

If the **HEX** control box is activated, a *.HEX file will be created containing the HEX dump.

If the **LST** control box is activated, a LIST file will be created containing the disassembled program.

This file can also be created including addresses, **LST with Addresses**.

If the **MAP** control box is activated, a *.MAP file will be created containing the memory allocation.

Data consistency errors

Some variable types cannot be read or written with a single processor access in a multi-tasking environment. Processing requires several accesses.

If a variable is simultaneously accessed by several tasks data inconsistency may occur.
The following data types are concerned:

- DWORD, DINT, UDINT, REAL, TIME
- BOOL, if the BOOL variable has an absolute address.
  (bMyBool AT %MX0.0: BOOL;)

Note!

If the Data consistency for multi-tasking checkbox is activated low-priority tasks can no longer be interrupted by high-priority tasks during read and write access. Read/write access of the low-priority task will be completed.

Data consistency must be ensured in the following cases:

- Bit access in the form of byMyByte.1:=TRUE

Use of older versions

Note!

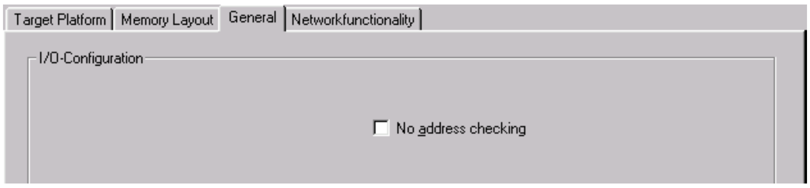
The following restrictions or behaviour can occur when older program versions or projects are used.

- If DDS 2.2 is used for the compilation of projects that were created with DDS 2.1 or 2.0 the runtime may change and a task overflow may occur when the Data consistency for multi-tasking checkbox is activated.
- If projects that were created with DDS 2.2 are opened with DDS 2.1 or 2.0 data consistency for multi-tasking is not supported. Data consistency and runtime errors may occur during the compilation with DDS 2.1 or 2.0.

Memory Layout

The index card is not editable.

General



Address checking is active by default so that the project can only use absolute addresses that have been entered in the PLC configuration.

The control box **No address checking** deactivates the address checking. When compiling the project, the IEC addresses will not be checked.

Network functionality

The index card is not active.

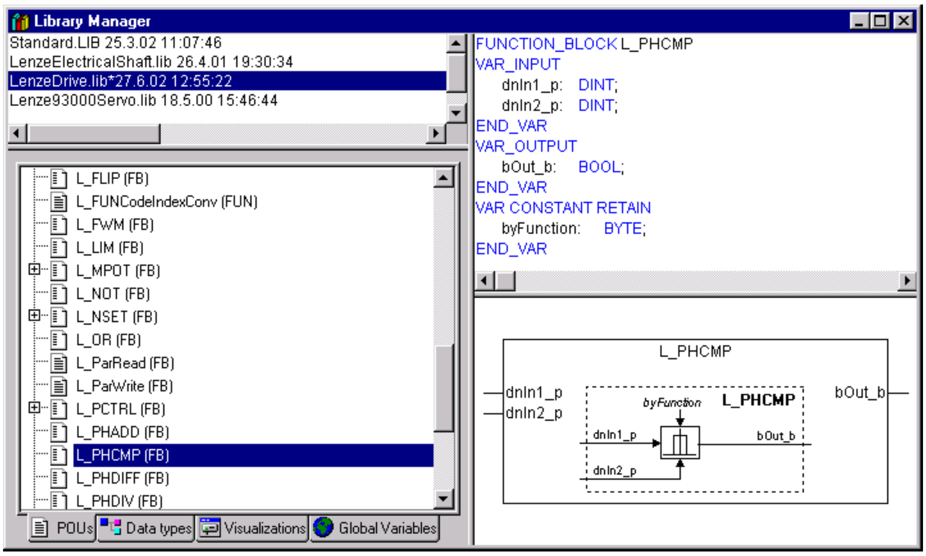
8.11 Library Manager

In the DDS, libraries are managed with the Library Manager that can be activated with the command **Window→Library Manager**.

- Information about the linked libraries is stored with the project.
- The Library Manager shows all libraries available for the current project.
- Organization units, data types, visualizations and global variables of the libraries can be used like user-defined organization units, data types, visualizations and global variables.

8.11.1 Library Manager window

The Library Manager window is split into three or four panes.



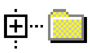
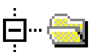
Libraries

The upper left-hand pane shows the libraries available for the project.

Organization units/data types/visualizations/global variables

Depending on the selected tab, the lower left-hand pane lists the organization units, data types, visualizations or global variables of the library selected in the upper pane.

- Folders are opened or closed with a double-click or by pressing **<Enter>**.
- A plus sign in front of the closed folder icon indicates that this folder contains objects and/or other folders.

	A click on the plus sign opens the folder and shows all subordinate objects. A minus sign now replaces the plus sign.
	A click on the minus sign closes the folder again.

Declaration / graphic representation of an organization unit

If an organization unit is selected by mouse click or arrow keys, the upper right-hand pane of the Library Manager will display the declaration of the organization unit, and the lower right-hand pane the graphic representation as black box with inputs and outputs.

Declaration of data types/global variables

The declaration of data types and global variables is displayed in the right-hand pane of the Library Manager.

Declaration of visualizations

For visualizations, the right-hand pane shows the used placeholders and the visualization.

8.11.1.1 Insert library

Icon: -	Menu: **Insert→Additional Libraries**	Keyboard: **<insert>**

Use this command to link another library to your project.

Selection of the command opens the dialog box *Open*.

- Select the required file (extension "*.lib") and click **OK**.

The library is now listed in the Library Manager, and the objects of the library can be used like user-defined objects.

Tip!

This command is also available via the shortcut menu (right mouse key) in the top left-hand pane of the Library Manager.

8.11.1.2 Properties

Icon: -	Menu: **Extras →Properties**	Keyboard: **<Alt>+<Enter>**

Use this command to obtain information on the selected library.

8.11.2 Included libraries

The DDS comes with the following libraries, among others:

Tip!

For a detailed description of the function blocks refer to the manual for the associated function library and the Online Help.

IEC 61131-3 standard library "Standard.lib"

The library **Standard.lib** contains all functions and function blocks required by IEC 61131-3 as standard organization blocks for an IEC programming system.

The difference between a standard function and an operator is that the operator is implicitly known to the programming system whereas the standard organization units must be linked to the project as library (standard.lib).

Library "LenzeDrive.lib"

The library **LenzeDrive.lib** includes function blocks to implement standard drive tasks for 9300 Servo PLC, Drive PLC and Servo Axis Module ECSxA.

- Multiple instancing of these function blocks as per IEC 61131-3 is possible.

Library "LenzeElectricalShaft.lib"

The library **LenzeElectricalShaft.lib** contains special function blocks for the "electrical shaft".

Library "Lenze9300Servo.lib"

The library **Lenze9300Servo.lib** contains special function blocks for the 9300 Servo PLC and Servo Axis Module ECSxA.

Library "Iecsfc.lib" for IEC steps in SFC

The library **Iecsfc.lib** contains IEC steps to be used in the Sequential Function Chart.

8.11.3 User-defined libraries

A complete and correctly compiled project can be saved under **File→Save as** as internal library (*.lib), external library (*.lib) or as project (*.pro).

- The project itself will not be changed.
- After the save, it will be available as the standard library under the specified name.

Saving the library removes the organization unit PLC-PRG from the project.

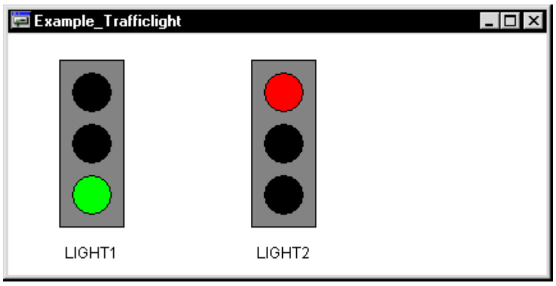
Note!

Saving the library removes the organization unit PLC-PRG from the project.

9 Visualization

Visualization is located on the tab **Visualization** in the *Object Organizer*.

Use visualization to draw geometrical elements in offline mode to change their shape or colour in online mode depending on certain variable values.



Tip!

Use the menu command **Project →Insert object** to create a new visualization object.

Placeholders allow a visualization object to be used more than once. A visualization object can be inserted into other visualization objects. Replacing the placeholders assigns different configurations to the visualization object.
Visualization objects inserted into other visualizations are called references. There are two options to configure a visualization object.

Depending on the configuration, a reference responds differently to actions in online mode.

- The individual elements of the reference respond like the original visualization.
- The individual elements of the reference remain unconsidered. The reference responds to inputs as an overall object.

Application examples:

- Have the behaviour of a variable displayed during growth in a bar graph.
- Program entries via mouse and keyboard.

If an appropriate translation file is available, texts can be displayed in a different language during online visualization.
Project →Translate into other languages (🕮 6-12)

9.1 Inserting visualization elements

Insertion mode

If the visualization level is active, the menu command **Insert** lists the various different visualization objects.

- The mouse pointer in the editor window turns to the icon of the element to be inserted.
- The status bar displays the name of the element to be inserted in black.
- After an element has been inserted, the process automatically changes to selection mode.

Selection mode

In selection mode, one or several elements can be selected for editing.

- To insert another element, change back to insertion mode with the right mouse button while keeping the **<Ctrl>** key depressed, or reselecting the associated insert command.

Tip!

Toggle between insertion and selection modes with the right mouse key while keeping the **<Ctrl>** key depressed.

9.1.1 Commands in the “Insert” menu

9.1.1.1 Rectangle

Icon:	Menu: **Insert →Rectangle**	Keyboard: -

Use this command to insert a rectangle as an element into your current visualization.

Command selection turns the mouse pointer into the associated icon in the editor window.

- Use the depressed left mouse key to size the element as required in the editor window.

9.1.1.2 Rounded rectangle

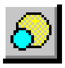
Icon:	Menu: **Insert →Rounded rectangle**	Keyboard: -

Use this command to insert a rounded-corner rectangle as an element into your current visualization.

Command selection turns the mouse pointer into the associated icon in the editor window.

- Use the depressed left mouse key to size the element as required in the editor window.

9.1.1.3 Ellipse

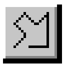
Icon: 	Menu: **Insert →Ellipse**	Keyboard: -

Use this command to insert an ellipse as element into your current visualization.

Command selection turns the mouse pointer into the associated icon in the editor window.

- Use the depressed left mouse key to size the element as required in the editor window.

9.1.1.4 Polyline

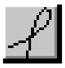
Icon: 	Menu: **Insert →Polyline**	Keyboard: -

Use this command to insert a polyline as element into your current visualization.

Command selection turns the mouse pointer into the associated icon in the editor window.

1. Click the starting point of the polyline in the editor window.
2. Click to add further reference points.
3. Double-click to complete the polyline.

9.1.1.5 Curve

Icon: 	Menu: **Insert →Curve**	Keyboard: -

Use this command to insert a curve (Beziers curve) as an element into your current visualization.

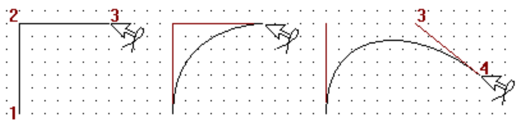
Command selection turns the mouse pointer into the associated icon in the editor window.

1. Click the required starting point of the curve in the editor window.
2. Click two other points to define the tangents of the curve.

The curve is being drawn. Its end point may be moved with the mouse.

3. Double-click to complete the curve, or use the mouse to expand it.

Example



9.1.1.6 Polygon

Icon:	Menu:	**Insert →Polygon**	Keyboard:	-

Use this command to insert a polygon as an element into your current visualization.

Command selection turns the mouse pointer into the associated icon in the editor window.

1. Click the required starting point of the polygon in the editor window.
2. Click to add further reference points.
3. Double-click to complete the polygon.

9.1.1.7 Bitmap

Icon:	Menu:	**Insert →Bitmap**	Keyboard:	-

Use this command to insert a graphic that must be in a bitmap (.bmp) or tagged image file format (.tif) as an element into your current visualization.

Command selection turns the mouse pointer into the associated icon in the editor window.

1. In the editor window, mark the area for the graphic, keeping the left mouse key depressed.
2. Select the graphic file to be inserted from the dialog box *Open* .

9.1.1.8 Visualization

Icon:	Menu:	**Insert →Visualization**	Keyboard:	-

Use this command to insert an existing visualization into your current visualization.

Command selection turns the mouse pointer into the associated icon in the editor window. An inserted visualization is called a reference.

1. In the editor window, mark the area for the visualization, keeping the left mouse key depressed.
2. In the dialog box *Select visualization* , select the visualization to be inserted.

9.1.1.9 Button

Icon:	Menu:	**Insert →Button**	Keyboard:	-

Use this command to insert a blank button into your current visualization.
The button will visualize any toggle variables configured for a button.

1. Size the element as required, keeping the left mouse key depressed.
2. The generated button can later be formatted with the menu command **Extras -> Configure** .

9.2 Editing visualization elements

9.2.1 Information in the status bar

The status bar contains the following information for visualization:

X /Y position

The current X and Y position of the mouse pointer is displayed in pixels relative to the top left-hand corner of the image.

Element number

If the mouse pointer is positioned over an element or if an element is edited, the number of the element will be displayed.

Insertion mode

If the insertion mode is active, the name of the element to be inserted will be displayed.

9.2.2 Expressions

The following inputs are possible if PLC variables are effective in the configuration of a visualization object.

- Variable name with Help Manager
- Composite expressions consisting of
  – component accesses (e. g. STRUCT)
  – field accesses (ARRAYaccess) with constant index
  – variables and direct addresses
- Operators and addresses that can be combined with the named expressions.

Examples of permissible expressions

```
x+y

100*PLC_PRG.a

TRUE

NOT PLC_PRG.b

q*sin(x+100)+cos(y+100)
```

The following inputs are not possible.

- Function calls
  Impermissible expressions lead to an error message during log-in
  (incorrect Watch expression)

Examples of impermissible expressions

```
fun(88)

a:=9

RETURN
```

Global variables can be written in two ways.

`.globvar` (not possible within a composite expression

`globvar`

9.2.3 Selecting visualization elements

Tip!
The commands for editing elements always refer to the element(s) currently selected.

Selecting one element

- Click the element to be selected.
- Pressing the **<Tab>**key also causes a jump to the first element in the element list. Press the key again to jump to the next element. Using the **<Tab>**key while keeping the **<Umschalt>**key depressed causes the system to jump in the opposite direction in the element list.

Selecting several elements

- Keep the **<Umschalt>** key depressed and click the associated elements one after the other.

or

- keep the left mouse key depressed to draw a window across the elements to be selected.

Selecting all elements

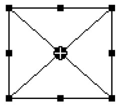
- Use the command **Extras→Select all** to select all elements of the visualization.

Processing from element list

- Use the command **Extras→Element list** to open the element list.
- This list includes the type and location of all generated elements. Use the button **Edit** to edit any selected element.

9.2.4 Changing size and shape of visualization elements

Once an element has been selected, its centre of rotation and reference points are marked in black.



- The size of the selected element can be changed by moving the respective reference point while keeping the left mouse key depressed.
- The centre of rotation of the visualization element can be moved by keeping the left mouse key depressed. The element will then move around this point according the set rotation/angle.

Polygon

Move reference point

- Keep the left mouse key depressed to move any reference point of a polygon.

Insert reference point

- Hold the **<Ctrl>**key while pressing the left mouse key to move the new reference point from an already existing reference point location to the desired position.

Remove reference point

- Hold the **<Umschalt>+<Ctrl>** keys and click the reference point to be removed.

9.2.5 Moving visualization elements

One or several selected elements can be moved using the arrow keys or keeping the left mouse key depressed.

9.2.6 Copying, cutting, inserting visualization elements

One or several selected elements can be copied, cut or inserted via the clipboard.

Copying with the <Ctrl> key

Elements may also be copied as follows:

- Select the elements to be copied.
- Press **<Ctrl>** and **<C>** simultaneously to copy one of the selected elements.
- Press **<Ctrl>** and **<V>** simultaneously to paste the copy slightly displaced from the original.
- Use the left mouse key to move the copy to the required location.

9.2.7 Deleting visualization elements

Use the commands **Edit→Delete** (**<Del>**key) or **Edit→Cut** to delete one or several selected elements.

- Selecting **Edit→Cut** will save the elements to the clipboard.

9.2.8 Commands in the “Extras” menu

9.2.8.1 Element list

Icon: -	Menu: **Extras →Element list**	Keyboard: -

Use this command to open the dialog box *Element list* that lists all visualization elements with their number, type and position.

- The position refers to the X and Y position of the top left- and bottom right-hand corner of the element.
- Once one or several elements has/have been selected, the respective elements will be highlighted in the visualization for a visual check, and the display may scroll to the section with the selected elements as required.

Buttons

- Use **To the foreground** to display the selected visualization elements in the foreground.
- Use **To the background** to move the selected visualization elements to the background.
- Use **Delete** to delete the selected visualization elements.
- Use **Undo** and **Redo** to undo and redo actions carried out before. These commands are analogous to **Edit→Undo** and **Edit→Redo**. The editor window will display any changes.
- Click **OK** to confirm the changes and close the dialog box.

9.2.8.2 To the foreground

Icon: -	Menu: **Extras →To the foreground**	Keyboard: -

Use this command to bring the selected visualization elements to the front.

9.2.8.3 To the background

Icon: -	Menu: **Extras →To the background**	Keyboard: -

Use this command to send the selected visualization elements to the back.

9.2.8.4 Align

Icon: -	Menu: **Extras →Align**	Keyboard: -

Use this command to align several selected visualization elements.

The following alignment options are available:

Left	All elements are aligned with their left-hand edge with the element on the extreme left.
Right / top / bottom	Alignment analogous to **Left**.
Horizontal middle	All elements are aligned by their horizontal centre within the centre of all elements.
Vertical middle	All elements are aligned by their vertical centre within the centre of all elements.

9.2.8.5 Select all

Icon: -	Menu: **Extras →Select all**	Keyboard: -

Use this command to select all visualization elements of the current visualization object.

9.2.8.6 Placeholder list

Icon:	-	Menu:	**Extras →Placeholder list**	Keyboard:	-

Every point of the configuration dialog **Extras→Configure**that allows variables or text to be input, also offers the possibility of entering a placeholder instead of the variables or the text.

This is appropriate if the visualization object is to be integrated into other visualization objects as a reference. On calling the respective reference, the placeholder can then be substituted accordingly with the variable or text.

The dialog shows the placeholders used in the current visualization object and allows a preliminary definition. The input focus must be on the visualization object.

On reference configuration, each placeholder can be substituted with the associated values.

Placeholders

This column lists the placeholders available for visualization.

Element numbers

Displays the number of the element for which the placeholder was generated. Also compare the element list numbers.

Replacements

This option allows the input of a selection of strings which the placeholder substitutes. The placeholder is the reference to the string. The strings must be comma-separated. Where no entry exists, the placeholder can be substituted with any text during reference configuration.

Possible replacements

Placeholder	Element number	Replacements
text	0	box_a, box_b
Change colour	0	pic_prg.var, var_changecolour1, pic_prg.var_changecolour2
text2	1	a, b, c, d
togglevar	0	

9.3 Configuring visualization elements

9.3.1 Commands in the "Extras" menu

9.3.1.1 Settings

Icon: -	Menu: **Extras →Settings**	Keyboard: -

Use this command to open the dialog box *Visualization settings* for the following settings:

Category View

- Text field **Zoom** permits a zoom factor from 10 to 500 %.
- If check box **Element numbers** is activated, the element number will be displayed for every element in offline mode.

Category Frame

- If check box **Auto scrolling** is activated, the visible area of the visualization window will be moved automatically when drawing or moving a visualization element when the window "frame" is reached.
- If check box **Automatic adaptation online** is activated, the visualization is adapted to the window size (all elements visible) in online mode.
- If check box **Include background bitmap** is activated, a ticked check box **Automatic adaptation online** means that the size of the bitmap is also considered when adapting the visualization to the window; otherwise only the elements will be considered.

Category Grid

- If check box **Visible** is activated, the pixels will be displayed in offline mode.
- If check box **Active** is activated, elements can only be positioned onto pixels during drawing and moving processes.
- Text field **Size** defines the spacing between pixels.

Tip!

The spacing between visible pixels is at least 10 pixels, even if the text field **Size** specifies less.

At a lower-than-10 spacing, the pixels will still appear at a 10-pixel spacing.

Category Language

- If check box **Language file** is active, a special language file *.vis can be generated.
- Use the button **...** to open a dialog to save the language file.
- The combination box **Language** allows language selection.
- The button **Save** stores the language file at the selected location.
- Use the button **OK** to save the dialog box settings.

Creating a language file

- Tick check box **Language file**. The group box **Language** is active.
- In the combination box **Language** enter "en", for example (English).
- Enter a path or use **...** to look for the directory in which the language file is to be saved. The file name, English.vis, for example, must be specified at the end.
- Press **Save** once the dialog box fields have all been completed. In the example, the file English.vis will be generated in the specified target path.

The created language file can be opened with a text editor.

9.3.1.2 Select background bitmap

Icon: -	Menu: **Extras→Select background bitmap**	Keyboard: -

Use this command to load a bitmap as background for the visualization.

Selection of the command opens the dialog box *Open file*.

- Select the required file with the extension ("*.bmp") and click **OK**.

The selected bitmap appears in the background of the visualization.

9.3.1.3 Delete background bitmap

Icon: -	Menu: **Extras→Delete background bitmap**	Keyboard: -

Use this command to delete the background bitmap of the current visualization.

9.3.1.4 Configure

Icon: -	Menu: **Extras→Configure**	Keyboard: -

Use this command to open the dialog box *Configure element* to configure the selected visualization element.

Tip!

The dialog box can also be opened by double-clicking an element.

Configure→Form available for: rectangle, rounded rectangle, ellipse

Use **Extras→Configure**, category *Form* to assign the shape *Rectangle*, *Rounded rectangle* or *Ellipse* to the selected element.

- The defined size remains unaffected.

Configure→Text available for: all

Use **Extras→Configure**, category *Text* to assign a text to the selected element. This text will be entered directly or substituted by a placeholder.

Contents

Use the input field **Contents** for text entry.
<Ctrl>+<Return> generates a line break
<Ctrl>+<Tab> generates tab stops

- An entry of "%s" means that this text is substituted in online mode by the value of the variable from text field **Text output** in the category *Variables*.

Caution!

If a translation file is to allow a switch into another national language in online mode, the specific text must be framed by #Text#.

#Pump 1# or #Pump# 1
If the text Pump (Pump1, Pump2 etc.) occurs several times, the second case will save several occurrences in the translation.

Horizontal/vertical

Selecting the respective check box defines the layout of the configured text within the element.

Font

Click **Font** to open the dialog box *Font* and select the font for the text.

Standard font

Click **Standard font** to use the font selected under **Project→Options**.

- If the font is changed under **Project→Options**, this change will affect all elements that were not explicitly assigned another font via button **Font**.

Configure→Line width

available for: all

Use **Extras→Configure**, category *Line width* to modify the line widths of the selected objects.

Configure→Colours

available for: rectangle, rounded rectangle, ellipse

Use **Extras→Configure**, category *Colours* to assign original colours and signal colours for fill and frame to the selected element.

- If a Boolean variable is entered under category *Variables*, field *Change colour*, the element will be displayed in the set colour as long as the variable is `FALSE`. If the variable is `TRUE`, the element will be displayed in signal colour.

Tip!

The Change colour function is active only if the control is in online mode or simulation!

- Click **Inside** or **Frame** to open the dialog box *Colours* and select the associated colour.

Configure→Motion absolute

available for: all

Use **Extras→Configure**, category *Motion absolute* to define a motion dependent on variable values for the selected element.

Tip!

To enter variables, use the Help Manager **<F2>**

X offset/Y offset

Use the input fields **X offset/Y offset** to enter variables whose values effect motion of the element in X or Y direction.

Scaling

Use the input field **Scaling** to enter a variable to define the size of the element.

Input and effect

	Magnification
1000	1:1 no change
100	x 0.1
10000	x 10

Angle

Use the input field **Angle** to enter a variable whose value causes element rotation (positive value = mathematically positive = CW rotation).

- The value is evaluated in degrees.
- The centre of rotation of a selected element can be moved, keeping the left mouse key depressed.

A variable in field **Angle** causes the current element to rotate. The rotation is brought about by positive values and follows a CW direction.

Configure→Motion relative available for: all except polygon

Use **Extras→Configure**, category *Motion relative* to assign variables to the edges of the selected element. The respective element edges move according to the variable values.

Tip!

To enter variables, use the Help Manager **<F2>**.

Every side of the element has its own input field.

- The normal edge position is zero, a new variable value in the associated column moves the border by this value in pixels. The entered variables should be variables of type `INT`.
- Positive values move the horizontal edges downward or the vertical edges to the right!

Configure→Variables available for: all

Use **Extras→Configure**, category *Variables* to define variables to describe the status of the selected element.

Tip!

To enter variables, use the Help Manager **<F2>**.

Invisible

If the variable in the input field **Invisible** is set to `FALSE`, the visualization element will be visible. If the variable is `TRUE`, the element will be invisible.

Change colour

If the variable in the input field **Change colour** is set to `FALSE`, the visualization element will be displayed in its original colour. If the variable is `TRUE`, the element will be displayed in its signal colour.

Text display

Use the input field **Text display** to enter a variable whose value will be output if the field **Content** in the category *Text* contains "%s" in addition to the text.

9.3.2 Formatted text display

The following tables provide a general formatted text display.

Char format

Element	Meaning
%	Formatted text display starts with %. If the character is to be included in the display for specific reasons, the first characters must be %%.
-	Display is left-aligned.
b	Display field minimum width
c	For Char variables

String format

Element	Meaning
%	Formatted text display starts with %. If the character is to be included in the display for specific reasons, the first characters must be %%.
-	Display is left-aligned.
b	Display field minimum width
.n	Width of the field section written by the string
s	For Char arrays

Integer format

Element	Meaning
%	Formatted text display starts with %. If the character is to be included in the display for specific reasons, the first characters must be %%.
-	Display is left-aligned.
+	Positive polarity
b	Display field minimum width
.n	Minimum number of display digits
Only one of the characters listed below appears at the end of the formatted text	
d	For Int variables
ld	For long Int variables

Format for polarity-free integers

Element	Meaning
%	Formatted text display starts with %. If the character is to be included in the display for specific reasons, the first characters must be %%.
-	Display is left-aligned.
#	Leading zero for hexadecimal and octal representation
b	Display field minimum width
.n	Minimum number of display digits
Only one of the characters listed below appears at the end of the formatted text	
d	Number in decimal 0-9
x	Number in hexadecimal 0-9 and a-f
X	Number in hexadecimal 0-9 and A-F
o	Octal 0-7 for polarity-free variables

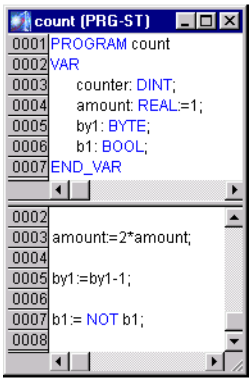
Format for floating-point numbers

Element	Meaning
%	Formatted text display starts with %. If the character is to be included in the display for specific reasons, the first characters must be %%.
-	Display is left-aligned.
+	Positive polarity
#	Leading zero for hexadecimal and octal representation
b	Display field minimum width
.n	Digits after the point, preset: 6
Only one of the characters listed below appears at the end of the formatted text	
lf	For double variables ddd.dddddd
f	For float variables ddd.dddddd
e	d.dddddddefdd
E	d.ddddddE±dd
g	Like f or e in shorter representation
G	Like F or E in shorter representation

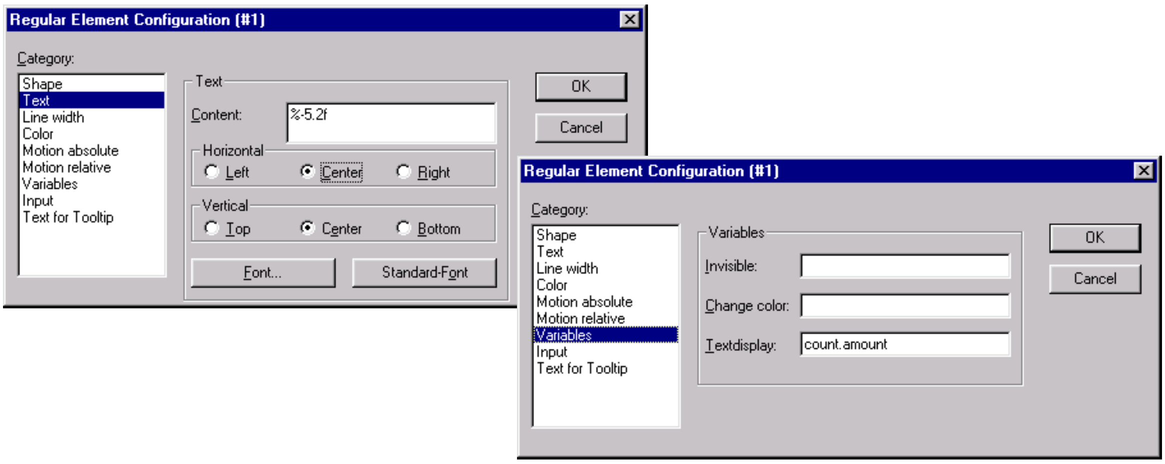
Program example

The following program example illustrates how a **Formatted number output** is represented in the DDS.

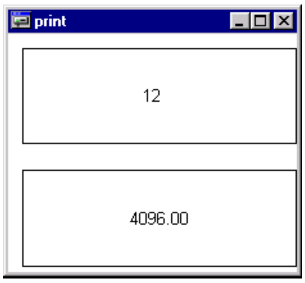
- Variables are declared and instructions written in the first step.



- Then visualization is established with the help of two rectangles. Element 0 is to be configured as follows. For element 1, the only input needs to be made in category *Variables* in **Text display:** `text.ftext2`.
- The input in category *Text*, input field **Content** consists of the **Formatted number display.**. The preset inputs should be accepted first.



- The display then is as follows in online mode. The previously made inputs return the representation below.



To test the effect of the **Formatted number display**, enter other formats as well with `%`.

- ”%s” will be substituted in online mode with the value of the variable entered in the input field **Text display**.

Configure→Input available for: all

Use **Extras→Configure**, category *Input* to define whether the online mode should allow mouse and keyboard inputs or not.

Toggle variable

If check box **Toggle variable** is activated, every mouse click will toggle the value of the Boolean variable entered in the input field behind.

- Every mouse click on the visualization element will toggle the value of the Boolean variable from `TRUE` to `FALSE` or from `FALSE` to `TRUE`.

Tip variable

If check box **Tip variable** is activated, the value of the Boolean variable specified in the input field behind will be changed by pressing the left mouse key and keeping it depressed.

- The value of the Boolean variable will change from `TRUE` to `FALSE` or from`FALSE` to `TRUE`when positioning the mouse pointer over the visualization element, then pressing the left mouse key and keeping it depressed.
- The value of the Boolean variable will return to its original status on releasing the left mouse key.
- If check box **Tip FALSE** is active, the value - on clicking **OK** - will change from TRUE to FALSE.

Caution!

This function cannot always be guaranteed to be reliable. Do not use Tip variable for safety-relevant drive control functions (such as positioning, for example).

Zoom to Vis

If check box **Zoom to Vis** is activated, a mouse click on the visualization element will take you to the window of the visualization selected in the input field.

- Activating check box **Toggle variable** as well will toggle the variable specified in text field **Toggle variable**.
- If a **`STRING-type program variable`** (e. g. `PLC_PRG.xxx`) is specified in the text field instead of the visualization, this variable may be used to preset the name of the visualization (e. g. `xxx:='visu1'`).
- If the text field **Zoom to Vis** is used to enter command **ZOOMTOCALLER**, the online mode provides for a return to the calling visualization by clicking the element, if such a constellation has been configured.

If a jump is to be executed to a visualization reference with placeholders, these may be substituted directly on call with variable names or texts.

Observe the following syntax.

```
<Visuname>(<Placeholder1>:=<Text1>,<Placeholder2>:=<Text2>,...,<Placeholdern>:=<Textn>)
```

Call for visualization visu1, where the placeholders used in visu1 var_ref1andvar_ref2 are substituted with variables PLC_PRG.var1 or PROG.var1.

```
visu1(var_ref1:=PLC_PRG.var1, var_ref2:=PROG.var1)
```

Execute program

If check box **Execute program** is activated, the executable program specified in the input field will be launched on clicking the visualization element.

Example

notepad C:/help.txt (the program Notepad will be started and the file help.txt opened).

Text input of variable 'Text display'

If check box **Text input of variable 'Text display'** is activated, a value can be assigned to a variable by clicking the visualization element.

- The value is assigned to the variable selected in category *Variables* in the text field **Text display**.
- Clicking the visualization element will display an input field for the new variable value. Press **<Enter>** to accept the value.

Configure→Text for tool tip available for: all

Use **Extras→Configure**, category **Text for tool tip** to enter a text for the selected element. This text is displayed when the mouse pointer is positioned briefly over the element.

- Line breaks in the text can be entered by pressing **<Ctrl>+<Enter>**.

Configure→Bitmap available for: Bitmap

Use **Extras→Configure**, category *Bitmap* to effect settings for the selected bitmap.

Bitmap

Use the input field **Bitmap** to enter the bitmap file and its path.

- Click **...** to open the standard dialog for browsing through the file structure to select the required file.
- Use check box **Transparent background** to define a colour contained in the bitmap as transparent. Use the button **Transparent colour** to define the colour.

Frame

- If check box **Anisotropic** is activated, the bitmap fills its frame and its size can be changed.
- If check box **Isotropic** is activated, the proportions of the bitmap always remain the same even if the size changes, i.e. the ratio between length and width remains the same.
- If check box **Fixed** is activated, the bitmap will be displayed in its original size, independent of its frame.
- If check box **Cut off** is activated, the setting *Fixed* only displays the framed part of the bitmap.
- If check box **Draw** is activated, the frame will be displayed in the colour selected under **Colour** and **Signal colour**. The signal colour will only be displayed if the variable entered in the category **Variables**, field *Change colour* is `TRUE`.

Configure→Visualization available for: visualization

Use **Extras→Configure**, category *Visualization* to effect the settings for a visualization inserted into the current visualization as an element. After insertion, this one is referred to as the **Reference** of the original one.

Visualization

Use the input field **Visualization** to enter the object name of the visualization.

- All visualizations except the current visualization and a reference to the current one can be specified.
- Click **...** to open the dialog box *Select visualization* to see a list of all visualizations available for this project.

Frame

- If check box **Draw** is activated, the frame will be displayed in the colour selected under **Colour** and **Signal colour** . The signal colour will only be displayed if the variable entered in the category *Variables* , field **Change colour** is `TRUE`.
- If check box **Isotropic** is activated, the proportions of the visualization always remain the same even if the size changes, i.e. the ratio between length and width remains the same.
- If check box **Cut off** is activated, only the original section of the visualization will be displayed in online mode. If an object reaches beyond the original display, for example, this object will be cut off and may not be visible any more.

- Button **Replace placeholder** opens dialog box *Replace placeholder*. All placeholders used in the inserted visualization organization unit will be listed. Column **Replacements** offers the option of replacing these with a specific value.
  The available substitutes are dependent on whether dialog box *Placeholder list* predefines a value set. The selection is displayed in a combination box. Where no predefinition has been made, a double-click on the associated field in the column Substitutes will open the placeholder in an edit field where it can be completed as required.
- Another option to substitute placeholders in references is directly on a visualization call via an entry in text field **Zoom to Vis:**, category *Input* of the configuration dialog for a visualization element.

Caution!

The chronological substitution sequence can not be influenced! No placeholders should be substituted with texts that include placeholders themselves!

The use of placeholders makes it impossible to check any invalid entries in the configuration of the visualization elements at the time of project compilation, so that any relevant error messages will be output in online mode only (”...incorrect Watch expression...”).

Placeholder concept

Example for using the placeholder concept

Function block instances can be easily displayed with references of the same visualisation.

When configuring visualisation elements, placeholders enable the visualisation objects to be used several times.

If a visualisation object created with placeholders is inserted into another visualisation, the placeholders are replaced by variables or strings.

Besides organisation units and global variables visualisation objects can also be stored in libraries. The use of placeholders enable the instances of the organisation unit to be referenced within the library.

Caution!

If after a visualization has been inserted, this reference is selected and configured, it will be considered object and respond as such to inputs in online mode in accordance with its configuration. If no configuration input is made for the reference at the point of insertion, its individual elements will respond like those of the original visualization in online mode.

Visualisation object with placeholders

- Declare the following function block in ST.

```
PROGRAM PLC_PRG

VAR

  nVar10:INT:=10;

  nVar20:INT:=20;

END_VAR
```

- A semicolon ";" must be entered into the instruction part.
- Create a new visualisation with the name Screen1 and insert a rectangle with **Insert→Rectangle**.
- Mark the rectangle and open the configuration dialog with **Extras→Configure**.
  In the category *Text*, input field **content**, enter the "variable value". The other options remain unchanged.
- In the category *Variables*, input field **Textdisplay**, enter "Ref". Placeholders are enclosed by the $ signs. The signs must be represented.
- Confirm the dialog with **OK**.
- Re-mark the rectangle. Open the dialog box *Placeholder: set possible replacements* with **Extras→List of Placeholders** complete the dialog box, and confirm with **OK**.

Placeholder	Elementnumber	Replacements
Ref	0	PLC_PRG.nVar10,PLC_PRG.nVar20

- Create another visualisation with the name Screen2.
- The visualisation Screen2 must be active. Insert a visualisation reference. Execute the menu command **Insert→Visualisation** and draw a rectangle in the visualisation Screen2. The dialog box *Select Visualization* is displayed Select Screen1 and confirm with **OK**.
- Mark the entire reference and open the configuration dialog. In the category *Visualization* (Screen1) press the button **Placeholder**. Select *PLC_PRG.nVar20.* from the replacements and confirm with **OK**.
- In the category *Visualization* (Screen1) only mark the control boxes **Isotropic** and **Clip** and confirm with **OK**.
- Store the program with a suitable name and log in.

9.3.2.1 Group

Icon: -	Menu: **Extras→Group**	Keyboard: -

Tip!
Group allows several elements to be moved simultaneously without affecting the distances in-between.

How to group

- Select the elements to be grouped.
- **Select Extras→Group**.
- Edit group (move, delete).
- Once the elements have been edited completely, the conglomerate can be ungrouped with **Extras→Break up group**.

9.4 Visualization in libraries

Visualizations can also be saved in libraries and thus be made available as library organization units in projects.

- Like the visualizations available in the project directly, they can be inserted as references.
- Use the command **Zoom to Vis** to open another visualization.

Tip!

The visualizations within a project must be uniquely named. Referenced and existing visualizations must bear uniquely different names.

Program execution first processes the visualizations within the project, and then those of the loaded libraries.

10 IEC 61131-3 data types

10.1 Standard data types

Standard or user-defined data types may be used for programming. Each identifier is assigned to a data type to define how much memory is to be reserved and which values correspond to the memory contents.

Standard data types are:

- BOOL
- Integer data types
  (BYTE, WORD, DWORD, SINT, USINT, INT, UINT, DINT, UDINT)
- REAL
- STRING
- Time data types
  (TIME, TIME_OF_DAY, DATE, DATE_AND_TIME)

10.1.1 BOOL

Variables of type `BOOL` can be `TRUE` or `FALSE` and are subject to an 8-bit memory reservation.

10.1.2 Integer data types

Integer data types include `BYTE`, `WORD`, `DWORD`, `SINT`, `USINT`, `INT`, `UINT`, `DINT`, `UDINT`.

Different data types cover different numerical ranges. The following range limits apply to integer data types:

Type	Lower limit	Upper limit	Memory
`Byte`	0	255	8 bits
`Word`	0	65535	16 bits
`DWORD`	0	4294967295	32 bits
`SINT`	-128	127	8 bits
`USINT`	0	255	8 bits
`INT`	-32768	32767	16 bits
`UINT`	0	65535	16 bits
`DINT`	-2147483648	2147483647	32 bits
`UDINT`	0	4294967295	32 bits

As a result, information may be lost when converting higher-order types to lower-order types.

10.1.3 REAL and LREAL

`REAL` and `LREAL` are so-called floating-point types required for the use of rational numbers. The reserved memory capacity amounts to 32 bits or 64 bits.

Note!

`LREAL` is not supported by the Lenze target systems.

Process `REAL` data types only in the `PLC_PRG` context. System errors may occur.

10.1.4 String

A variable of type **STRING** can hold variable-length sequences of characters. The size specified for memory reservation in the declaration is character-based and may be given in round or square brackets. Where no value has been specified (1 to 255), the default is assumed as **20 characters**.

Example of a 20-character string declaration:

```
str:STRING(20):='This is a string';
```

10.1.5 Time data types

The data types **TIME**, **TIME_OF_DAY** (in short TOD), **DATE** and **DATE_AND_TIME** (in short **DT**) are processed internally like **DWORD**.

- **TIME** and **TIME_OF_DAY** specify time in milliseconds, with the count starting at **TOD** 00:00 o'clock.
- **DATE** and **DT** specify time in milliseconds, starting with the 1st of January 1970 at 00:00 o'clock.
- In the time specification, **h** = hours, **m** = minutes, **s** = seconds and **ms** = milliseconds.

Example

```
TIME#2h4m12s123ms
```

10.2 Defined data types:

10.2.1 Array

One, two, and three-dimensional arrays of elementary data types are supported. Arrays can be defined in the declaration part of an organization unit or in a global variable list. Structures may also form arrays.

Syntax:

```
<Field_name>:ARRAY [<ll1>..<ul1>,<ll2>..<ul2>] OF <elem. type>.
```

- <ll1>, `<ll2>` specify the lower field range limit.
- <ul1>, `<ul2>` specify the upper field range limit.
- Limit values must be integers.

The following syntax is used to access components of arrays in the case of a two-dimensional field:

```
<Field_name>[Index1,Index2]
```

Example:

Declaration

```
Card game : ARRAY [1..13, 1..4] OF INT;
```

Implementation

```
Card game[9,2]
```

Initializing arrays:

Either all elements of an array are initialized, or none.

Examples of array initializations:

```
arr1 : ARRAY [1..5] OF INT := 1,2,3,4,5;

arr2 : ARRAY [1..2,3..4] OF INT := 1,3(7);
(* short for 1,7,7,7 *)

arr3 : ARRAY [1..2,2..3,3..4] OF INT := 2(0),4(4),2,3;
(* short for 0,0,4,4,4,4,2,3 *)
```

Example for the initialization of an array within a structure:

```
TYPE STRUCT1
 STRUCT
 p1:INT;
 p2:INT;
 p3:DWORD;
END_STRUCT

ARRAY[1..3]OF STRUCT1:=(p1:=1,p2:=10,p3:=4723),(p1:=2,p2:=0,p3:=299),
(p1:=14,p2:=5,p3:=112);
```

Elements without pre-assigned values are initialized with the basic type's default initial value. In the above example, the elements anarray[6] to anarray[10] are therefore initialized with 0.

Tip!

The function CheckBounds in library CheckBounds.lib may be used to automatically check whether an array exceeds its limits.
Also note CheckBounds.lib.

Library CheckBounds.lib

The library CheckBounds contains the global variable *g_bErrorCheckBounds*.

- Open the library management with **Window→Library Manager**.
- Insert the library from the library folder. Via the menu command **Insert→Additional Library**, you can select the library and insert it into the actual project.
- Select the library in the library management. On the index card **Global Variables**, the variable and additional information are listed.

Note!

The global variable *g_bErrorCheckBounds* monitors accesses to an array that is not within the defined limits.

The function **CheckBounds** of the library recognizes that the target system uses an array outside its defined limits.

- The global variable *g_bErrorCheckBounds* is set to TRUE.
- The status TRUE is not set back during runtime. If the status = TRUE, at least once an array has been accessed outside its defined limits.

If an integral project component, the function CheckBounds is called up automatically. A separate call for the function in the implementation is not required.

If the function CheckBounds is not an integral project component, an array is not prevented from exceeding its limits.

Where indirect accesses made to an array outside its limits, CheckBounds forces access to the first or last array element.

Implementation

Declaration part

```
FUNCTION Checkbounds : INT
VAR_INPUT
   index,lower,upper:INT;
END_VAR
```

Instruction part

```
IF index < lower THEN
   CheckBounds := lower;
ELSEIF index > upper THEN
   CheckbBounds := upper;
ELSE
   CheckBounds := index;
END_IF
```

The following program example for testing the CheckBounds function accesses outside the limits of a defined array. The function CheckBounds ensures that the value TRUE is not assigned to A[10], but to the still-valid upper range limit A[7]. The CheckBounds function can thus be used to intercept any access beyond the array limits.

Declaration part

```
PROGRAM PLC_PRG
VAR
   A:ARRAY[0..7] OF BOOL;
   B:INT:=10;
```

Instruction part

```
A[B]:=TRUE;
```

10.2.2 Pointers

Pointers are used to save addresses of variables or function blocks at program runtime.

Warning!

Applied wrongly, pointers may crash the target system. For this reason, do not use pointers.

If you use pointers, do so with great care. Writing of WORD data types on odd addresses or accessing system memory areas can cause errors.

Pointer declarations have the following syntax:

```
<Identifier>: POINTER TO <Data type/Function block>;
```

A pointer can point to any data type or function block, including user-defined function blocks.

Use address operator **ADR** to assign a variable or function block address to the pointer.

Pointers are de-referenced via the contents operator ^ behind the pointer identifier.

Example:

Declaration

```
pt:POINTER TO INT;
var_int1:INT := 5;
var_int2:INT;
```

Implementation

```
pt := ADR(var_int1);
var_int2:= pt^; (* var_int2 is now 5 *)
```

10.2.3 Enumeration type

An enumeration type is a user-defined data type that consists of several string constants. These constants are referred to as enumeration values.

Enumeration values are known throughout the entire project even if they were locally declared in an organization unit. They are best created as objects in the *Object Organizer* on the index card **Data types**. They start with the keyword **TYPE** and end with **END_TYPE**.

Syntax:

```
TYPE <Identifier>:(<Enum_0> ,<Enum_1>, ...,<Enum_n>);
END_TYPE
```

The values are compatible with integers, i.e. operations can be carried out as with **INT**. A number x may be assigned to the <Identifier>. This applies to variables only. If the enumeration values are not initialized, counting starts at 0. Each enumeration takes up 1 byte of memory.

Ensure when initializing that the initial values are in ascending order. The validity of the number is checked at runtime.

Example:

```
TYPE
  TRAFFICLIGHT: (red, yellow, green:=10);
  (* red has the initial value 0, yellow 1, green 10 *)
END_TYPE
```

Declaration

```
TRAFFICLIGHT1:TRAFFICLIGHT:=0; (* TRAFFICLIGHT1 has the value red *)
```

Implementation

```
IF TRAFFICLIGHT = red THEN
   TRAFFICLIGHT := GREEN;
END_IF
```

No enumeration value must be used twice.

Example:

```
TRAFFICLIHTS: (red, yellow, green);
COLOUR: (blue, white, red);
```

Error: red must not be used for `TRAFFICLIGHTS` and `COLOUR`.

10.2.4 Structures

Structures are saved as objects in the *Object Organizer* on the index card **Data types**, start with the keywords **`TYPE`** and **`STRUCT`** and end with **`END_STRUCT`** and **`END_TYPE`**.

Structure declarations have the following syntax:

```
TYPE <Structure name>:
  STRUCT
    <Variable declaration 1>
    .
    .
    <Variable declaration n>
  END_STRUCT
END_TYPE
```

<Structure name> is now a type known throughout the entire project and can be used like a standard data type.

Nested structures are permitted, the only restriction being that variables cannot be set to addresses. **An AT declaration is not permitted!**

Structure components are accessed with the following syntax:

```
<Structure_name>.<Component name>
```

For instance, the structure ”Week” including the component ”Monday” can be accessed as follows:

```
Week.Monday
```

Example:

Structure definition for a polygon

```
TYPE Polygon:
  STRUCT
    Start: ARRAY [1..2] OF INT;
    Point1:ARRAY [1..2] OF INT;
    Point2:ARRAY [1..2] OF INT;
    Point3:ARRAY [1..2] OF INT;
    Point4:ARRAY [1..2] OF INT;
    End:  ARRAY [1..2] OF INT;
  END_STRUCT
END_TYPE
```

10.2.5 References

The user-defined data type "Reference" generates an alternative name for a variable, constant or function block.

Organize your references as objects in the *Object Organizer* on the index card **Data types**. They start with the keyword **TYPE** and end with **END_TYPE**.

Syntax:

```
TYPE <Identifier>: <Assignment expression>;
END_TYPE
```

Example:

```
TYPE message:STRING[20];
END_TYPE;
```

10.2.6 Subrange types

The value range of a subrange type merely comprises a basic type subset. Declaration may be on the Data types index card. A variable can also be declared directly with a subrange type.

Syntax for declaration on the Data types index card

```
TYPE<Name>:<Inttype>(<ll>..<ul>):=Initial value;END_TYPE
```

<NAME>	Must be a valid IEC identifier.
<Inttype>	One of the data types SINT, USINT, INT, UINT, DINT, UDINT, BYTE, WORD, DWORD
<ll>	Is a constant that must be compatible with the basic type and defines the range type lower limit. The lower limit pertains to this range.
	Is a constant that must be compatible with the basic type and defines the range type upper limit. The upper limit pertains to this basic type.

```
TYPE
  SubInt : INT (-4095..4095);
END_TYPE
```

- Direct declaration of a variable with a subrange type.
- Correct specification of an initial value if the subrange does not include 0.

```
VAR
  i1 : INT (-4095..4095);
  i2: INT (5..10):=5;
  ui : UINT (0..10000);
END_VAR
```

Error message

The assigned constant of a subrange type (declaration or implementation) must be within the value range as otherwise an error message will be output.

Library CheckRange.lib

The library CheckBounds contains the global variable *g_bErrorCheckRange*.

- Open the library management with **Window→Library Manager**.
- Insert the library from the library folder. Via the menu command **Insert→Additional Library**, you can select the library and insert it into the actual project.
- Select the library in the library management. On the index card **Global Variables**, the variable and additional information are listed.

Note!

The global variable *g_bErrorCheckRange* monitors critical and not to be processed value ranges.

The library function **CheckRange** recognizes that the target system has reached a critical value range.

- The global variable *g_bErrorCheckBounds* is set to TRUE.
- The status TRUE is not set back during runtime. If the status = TRUE, at least once a critical value range has been reached.

CheckRangeSigned and CheckRangeUnsigned

In order to use these function, the library CheckRange.lib must be linked.

The function CheckRangeSigned and CheckRangeUnsigned must be added to enable runtime range limit checks and to prevent range infringements (by clipping the value or error flag). CheckRangeSigned and CheckRangeUnsigned are called up implicitly if a variable is written to. This variable is of a subrange type generated from a signed or unsigned type.

In the case of a variable of a signed subrange type (var:i1 or i2 listing above), the process calls up the function CheckRangeSigned. Programming might look as follows to clip the value to the permitted range.

```
FUNCTION CheckRangeSigned : DINT
VAR_INPUT
  value, lower, upper: DINT;
END_VAR

IF (value < lower) THEN
  CheckRangeSigned := lower;
ELSIF(value > upper) THEN
  CheckRangeSigned := upper;
ELSE
  CheckRangeSigned := value;
END_IF
```

Caution!

If the two functions CheckRangeSigned and CheckRangeUnsigned do not exist, the subrange types will not be type-checked at runtime! Variables i1 or i2 could then assume any value between -32768 and 32767!

Parameterizing the function

value	Is given the value to be assigned to the range type.
lower	The lower range limit.
upper	The upper range limit.
return value	The actually assigned value for the range type.

In this example, the following assignment is implicitly generated from an assignment i := 10*y;:
i := CheckRangeSigned(10*y, -4095, 4095);

If y has e.g. the value 1000, i will only have the value 4095 in accordance with this assignment.

Function CheckrangeUnsigned requires function name and interface to be correct.

```
FUNCTION CheckRangeUnsigned : UDINT
VAR_INPUT
  value, lower, upper: UDINT;
END_VAR
```

Functions CheckRangeSigned and CheckRangeUnsigned are available in library CheckRange.lib. Use the Library Manager **Insert→Additional Library** to insert the library into the project.

Tip!

If a function CheckRangeSigned or CheckRangeUnsigned is implemented as shown above, use of the subrange type in a FOR loop may result in an endless loop. This occurs if the range specified for the FOR loop is equal to or greater than that of the subrange.

```
VAR
  ui : UINT (0..10000);
END_VAR

FOR ui:=0 TO 10000 DO
...
END_FOR
```

The FOR loop is not exited as ui cannot exceed 10000.

Observe the content of the CheckRange functions when using incrementation values in the FOR loop!

11 Operator list

The table below lists the **operators** in ST and IL with the modifiers available in IL.

Column **Operator IL** displays only the line, using the operator.

Prerequisite:
The first required operator must have been loaded in the preceding line (e. g. LD in)

Column **Mod.IL** lists the modifiers available in IL.

C	The instruction will be carried out only if the result of the preceding expression is TRUE.
N	**For JMPC, CALC, RETC** The instruction will be carried out only if the result of the preceding expression is FALSE.
N	**Otherwise** Negation of the operand (not of the accumulator).
(	Parentheses frame operator; the operation in front will be executed only after the right parenthesis has been reached.

11.1 DDS-integrated IEC operators

Operator ST	Operator IL	Mod.IL	Meaning
'			String frame (e.g. 'string1')
.. [ ]			Array: Representation of the array range (e.g. ARRAY[0..3] OF INT)
:			Separator between operand and type in the declaration (e.g. var1 : INT;)
;			Closing instruction (e.g. a:=var1;)
^			Dereference pointer (e.g. pointer1^)
	LD var1	N	Load value of var1 into the accumulator
:=	ST var1	N	Save current result at operand position var1
	S boolvar		Set Boolean operand boolvar to TRUE exactly if the current result is TRUE
	R boolvar		Set Boolean operand to FALSE exactly if the current result is TRUE
	JMP label	CN	Jump to label
<Program name>	CAL prog1	CN	Call program prog1
<Instance name>	CAL inst1	CN	Call function block instance inst1
<Fktname>(vx, vy,..)	<Fktname> vx, vy	CN	Call function and transfer variables vx, vy
RETURN	RET	CN	Exit organization unit and, if necessary, return to calling unit.
	(		Value following the parenthesis is taken as the operand, the preceding operation is put on hold until the right parenthesis is reached
	)		Evaluate operation on hold
AND	AND	N,(	Bit-by-bit AND
OR	OR	N,(	Bit-by-bit OR
XOR	XOR	N,(	Bit-by-bit exclusive OR
NOT	NOT		Bit-by-bit NOT
+	ADD	(	Addition
-	SUB	(	Subtraction
*	MUL	(	Multiplication
/	DIV	(	Division
>	GT	(	Greater than
>=	GE	(	Greater than/equal to
=	EQ	(	Equal to
<>	NE	(	Not equal to
<=	LE	(	Less than/equal to

Operator ST	Operator IL	Mod.IL	Meaning
<	LT	(	Less than
MOD(in)	MOD		Modulo division
INDEXOF(in)	INDEXOF		Internal index of an organization unit in1; [INT]
SIZEOF(in)	SIZEOF		Required number of bytes for data type specified for in
SHL(K,in)	SHL K		Shift bits left by K within an operand
SHR(K,in)	SHR K		Shift bits right by K within an operand
ROL(K,in)	ROL K		Rotate bits left by K within an operand
ROR(K,in)	ROR K		Rotate bits right by K within an operand
SEL(G,in0,in1)	SEL in 0, in 1		Binary selection between two operands in0 (G is FALSE) and in1 (G is TRUE)
MAX(in0,in1)	MAX in 1		Return the greater of 2 values
MIN(in0,in1)	MIN in1		Return the lesser of 2 values
LIMIT(MIN,in,Max)	LIMIT MIN, MAX		Limit the value range (will be reset to Min. or Max. if exceeded)
MUX(K,in0,...in_n)	MUX in0,...,in_1		Select the Kth value from a number of values (in0 to In_n)
ADR(in)	ADR		Address of the operand in [DWORD]
BOOL_TO_<type>(in)	BOOL_TO_<type>		Type conversion of the Boolean operand into a different elementary type
BYTE_TO_<type>(in)	INT_TO_<type>		Type conversion of the BYTE operand into a different elementary type
WORD_TO_<type>(in)	INT_TO_<type>		Type conversion of the WORD operand into a different elementary type
<type>_TO_BOOL(in)	<type>_TO_BOOL		Type conversion of the operand to BOOL
INT_TO_<type>(in)	INT_TO_<type>		Type conversion of the INT operand into a different elementary type
DINT_TO_<type>(in)	DINT_TO_<type>		Type conversion of the DINT operand into a different elementary type
REAL_TO_<type>(in)	REAL_TO_<type>		Type conversion of the REAL operand into a different elementary type
LREAL_TO_<type>(in)	LREAL_TO_<type>		Type conversion of the LREAL operand into a different elementary type
TIME_TO_<type>(in)	TIME_TO_<type>		Type conversion of the TIME operand into a different elementary type
TOD_TO_<type>(in)	TOD_TO__<type>		Type conversion of the TOD operand into a different elementary type
DATE_TO_<type>(in)	DATE_TO_<type>		Type conversion of the operand into a different elementary type
DT_TO_<type>(in)	DT_TO_<type>		Type conversion of the operand into a different elementary type
STRING_TO_<type>(in)	STRING_TO_<type>		Type conversion of the operand into a different elementary type, in must contain valid value of the target type
TRUNC(in)	TRUNC		Conversion from REAL to INT
ABS(in)	ABS		Absolute value of the operand
SQRT(in)	SQRT		Square root of the operand
LN(in)	LN		Natural logarithm of the operand
LOG(in)	LOG		Logarithm of the operand to the base of 10
EXP(in)	EXP		Exponential function of the operand
SIN(in)	SIN		Sine of the operand
COS(in)	COS		Cosine of the operand
TAN(in)	TAN		Tangent of the operand
ASIN(in)	ASIN		Arc sine of the operand
ACOS(in)	ACOS		Arc cosine of the operand
ATAN(in)	ATAN		Arc tangent of the operand
EXPT(in,expt)	EXPT expt		Exponentiation of the operand by expt

11.2 Standard.lib-integrated IEC operators

Operator ST	Operator IL	Mod.IL	Meaning
LEN(in)	LEN		String length of the operand
LEFT(str,size)	LEFT size		Left-hand start string (size) of string str
RIGHT(str,size)	RIGHT size		Right-hand start string (size) of string str
MID(str,size)	MID size		Segment of size from string str
CONCAT('str1','str2')	CONCAT 'str2'		Concatenation of two strings
INSERT('str1','str2',pos)	INSERT 'str2',pos		Insert string str1 in string str2 at position pos
DELETE('str1',len,pos)	DELETE len,pos		Delete segment of length len, starting at position pos of str1
REPLACE('str1','str2',len,pos)	REPLACE 'str2',len,pos		Replace segment of length len, starting at position pos of str1 with str2
FIND('str1','str2')	FIND 'str2'		Find a segment str2 in str1
SR	SR		Set bistabile function block to dominant set
RS	RS		Reset bistable function block
SEMA	SEMA		FB: Software semaphore (interruptible)
R_TRIG	R_TRIG		FB: Rising edge detected
F_TRIG	F_TRIG		FB: Falling edge detected
CTU	CTU		FB: Up counter
CTD	CTD		FB: Down counter
CTUD	CTUD		FB: Up and down counter
TP	TP		FB: Pulse encoder
TON	TON		FB: On delay
TOF	TOF		FB: Off delay
RTC	RTC		FB: Runtime clock

For a detailed description refer associated libraries.

12 IEC 61131-3 operators

The DDS supports all IEC operators.

Contrary to standard functions, they are known implicitly throughout the entire project. Organization unit implementations use operators like functions.

12.1 Arithmetic operators

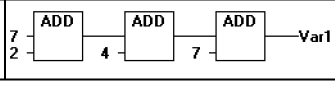
Types:

The operands of the following arithmetic operators can be of type **BYTE**, **WORD**, **DWORD**, **SINT**, **USINT**, **INT**, **UINT**, **DINT**, **UDINT** and **REAL**.

12.1.1 ADD

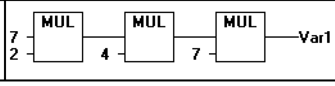
Addition

It is also possible to add two **TIME** variables, the sum being again a time (e.g. t#45s + t#50s = t#1m35s).

Examples		
IL	**ST**	**FBD**
`LD 7` `ADD 2,4,7` `ST Var1`	`Var1 := 7+2+4+7;`	

12.1.2 MUL

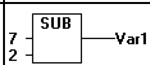
Multiplication

Examples		
IL	**ST**	**FBD**
`LD 7` `MUL 2,4,7` `ST Var1`	`Var1 := 7*2*4*7;`	

12.1.3 SUB

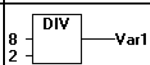
Subtraction

A **TIME** variable can also be subtracted from another **TIME** variable, the result being again of type **TIME**. Note that negative **TIME** values are not defined.

Examples		
IL	**ST**	**FBD**
`LD 7` `SUB 2` `ST Var1`	`Var1 := 7-2;`	

12.1.4 DIV

Division

Examples		
IL	**ST**	**FBD**
`LD 8` `DIV 2` `ST Var1`	`Var1 := 8/2;`	

Library CheckDiv.lib

The library CheckDiv contains the global variable *g_bErrorCheckDiv*

- Open the library management with **Window→Library Manager**.
- Insert the library from the library folder. Via the menu command **Insert→Additional Library**, you can select the library and insert it into the actual project.
- Select the library in the library management. On the index card **Global Variables**, the variable and additional information are listed.

Note!

The global variable *g_bErrorCheckDiv* checks for divisions by zero.

The library function **CheckDiv** recognizes that the target system has executed a division by zero.

- The global variable *g_bErrorCheckDiv* is set to TRUE.
- The status TRUE is not set back during runtime. If the status = TRUE, at least once a division by zero has been executed.

Note!

Use of CheckDiv functions.

CheckDiv functions do not allow divisions by zero. The divisor zero is replaced by one.

The following functions are available in CheckDiv.lib.

CheckDivByte

CheckDivDint

CheckDivDWord

CheckDivInt

CheckDivReal

CheckDivSInt

CheckDivUDint

CheckDivUInt

CheckDivUSInt

CheckDivWord

If a DIV operator is used, the value of the divisor can be checked. The respective function must have exactly the shown syntax. In the case of a division by zero(100/0), the divisor is replaced by one (100/1). At the same time the variable *g_bErrorCheckdiv* is set to *TRUE*.

Implementing CheckDivReal

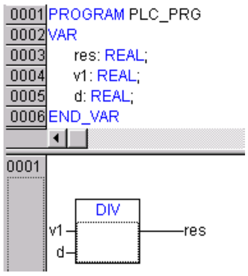
Declaration part

```
FUNCTION CheckDivReal:REAL
VAR_INPUT
  divisor:REAL;
END_VAR
```

Instruction part

```
IF divisor = 0 THEN
  CheckDivReal:=1;
ELSE
  CheckDivReal:=divisor;
END_IF;
```

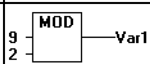
The operator DIV uses the result of function **CheckDivReal** as divisor. In the program example illustrated below, this prevents a division by 0 by setting the divisor (d) from 0 to 1. The result erg of the division is therefore 799.



12.1.5 MOD

Modulo division

Modulo division of a variable of type BYTE; WORD; DWORD; SINT; USINT; INT; UINT; DINT; UDINT with another variable of one of these types. The result of this function is an integer remainder of the division.

Examples		
IL	**ST**	**FBD**
LD 9 MOD 2 ST Var1 (* Var1 = 1 *)	Var1 := 9 MOD 2;	

12.1.6 INDEXOF

The result of this function is the internal index of an organization unit.

Examples		
IL	**ST**	**FBD**
	Var1 := INDEXOF(organization unit2);	

12.1.7 SIZEOF

The result of this function is the number of bytes required by the specified data type.

<table>
<tr><th colspan="3">Examples</th></tr>
<tr><td>IL
Declaration</td><td>ST
Declaration</td><td>FBD</td></tr>
<tr><td><code>arr1:ARRAY[0..4] OF INT;</code>
<code>Var1:=INT;</code>
Implementation
LD arr1
SIZEOF
ST Var1 (* Var1 = 10 *)</td><td><code>arr:ARRAY[0...4]OF INT;</code>
<code>Var1:INT;</code>
Implementation
Var1=SIZE OF (arr1);</td><td></td></tr>
</table>

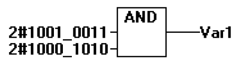
12.2 Bit-string operators

Types:

The operands of the following bit-string operators should be of type **`BOOL`**, **`BYTE`**, **`WORD`** or **`DWORD`**.

12.2.1 AND

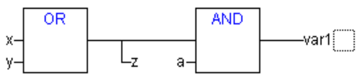
Bit-by-bit AND of bit operands

<table>
<tr><th colspan="2">Examples</th></tr>
<tr><td>IL<pre>Var1 : BYTE;
LD 2#1001_0011
AND 2#1000_1010
ST Var1   (* Var1 = 2#1000_0010 *)</pre></td><td rowspan="2">FBD

</td></tr>
<tr><td>ST <code>var1 := 2#1001_0011 AND 2#1000_1010</code></td></tr>
</table>

Note!

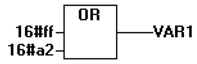
Make sure to observe the following when using 68xxx or C-code generators in the FBD for the illustrated program sequence.

As soon as the input variable a assumes the value FALSE, the assignment of the value of the second input variable at the AND operator organization unit to the variable z will no longer be performed as a consequence of the optimized processing procedure within the FBD.



12.2.2 OR

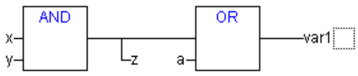
Bit-by-bit OR of bit operands

Examples			
IL	`Var1 : BYTE;` `LD  2#1001_0011` `OR  2#1000_1010` `ST  Var1          (* Var1 = 2#1001_1011 *)`	**FBD**	
ST	`Var1 := 2#1001_0011 OR 2#1000_1010`		

Note!

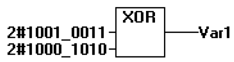
Make sure to observe the following when using 68xxx or C-code generators in the FBD for the illustrated program sequence.

As soon as the input variable a assumes the value TRUE, the assignment of the value of the second input variable at the OR operator organization unit to the variable z will no longer be performed as a consequence of the optimized processing procedure within the FBD.



12.2.3 XOR

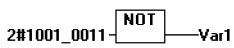
Bit-by-bit XOR of bit operands

Examples			
IL	`Var1 : BYTE;` `LD  2#1001_0011` `XOR 2#1000_1010` `ST  Var1     (* Var1 = 2#0001_1001 *)`	**FBD**	
ST	`Var1 := 2#1001_0011 XOR 2#1000_1010`		

12.2.4 NOT

Bit-by-bit inversion of a bit operand

The operand should be of type BOOL, BYTE, WORD or DWORD.

Examples			
IL	`Var1 : BYTE;` `LD  2#1001_0011` `NOT` `ST  Var1     (* Result = 2#0110_1100 *)`	**FBD**	
ST	`Var1 := NOT 2#1001_0011`		

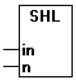
12.3 Bit-shift operators

Types:

The operands of the following bit shift operators should be of type **BYTE**, **WORD** or **DWORD**.

12.3.1 SHL

Shifting the bits of an operand to the left




```
A:= SHL (IN, N)
```

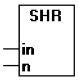
Example IL:

```
LD   1
SHL  1
ST   Var1     (* Var1 = 2 *)
```

IN is shifted to the left by N bits, and padded with zeros from the right.

12.3.2 SHR

Shifting the bits of an operand to the right




```
A:= SHR (IN, N)
```

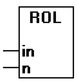
Example IL:

```
LD   32
SHL  2
ST Var1     (* Var1 = 8 *)
```

IN is shifted to the right by N bits, and padded with zeros from the left.

12.3.3 ROL

Rotating the bits of an operand to the left




```
A:= ROL (IN, N)
```

Example IL:

```
LD   2#1001_0011
ROL  3
ST   Var1
 (* Var1 = 2#1001_1100 *
```

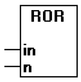
IN is rotated by one bit position to the left N times, with the bit on the extreme left being reinserted from the right.

Tip!

The number of bits for the arithmetic operation is specified by the data type of input variable IN. A constant is considered as the lowest-order data type. The data type of the output variable has no effect on the arithmetic operation.

12.3.4 ROR

Rotating the bits of an operand to the right

 `A:= ROR (IN, N)`	**Example IL:** **LD 2#1001_0011** **ROR 3** **ST Var1** **(* Var1 = #0111_0010 *)**

`IN` is rotated by one bit position to the right `N` times, with the bit being on the extreme right being reinserted from the left.

Tip!

The number of bits for the arithmetic operation is specified by the data type of input variable `IN`. A constant is considered as the lowest-order data type. The data type of the output variable has no effect on the arithmetic operation.

12.4 Selection operators

All selection operations can also be carried out on variables.
For better understanding, the examples below use constants as operands.

12.4.1 SEL

Binary selection

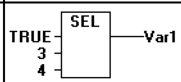
```
OUT := SEL(G, IN0, IN1)
```

means:

```
IF G THEN
  OUT:=IN1;
ELSE
  OUT:=IN0;
END_IF
```

`IN0`, `IN1` and `OUT` can be of any type, `G` must be of type **`BOOL`**.
The result of the selection is

- `IN0` if `G` is **`FALSE`**,
- `IN1` if `G` is **`TRUE`**.

Examples		
IL	**ST**	**FBD**
`LD  TRUE` `SEL 3,4     (*IN0=3, IN1=4*)` `ST  Var1    (*Result=4 *)` `LD  FALSE` `SEL 3,4` `ST  Var1    (*Result=3*)`	`Var1:=SEL(TRUE,3,4);` `(*Result Var1=4*)`	

Tip!
Processing is as follows for runtime optimization.
An expression attached to the input side of `IN0` will be computed only if `G = FALSE`.
An expression attached to the input side of `IN1` will be computed only if `G = TRUE`.

Simulation will compute all branches.

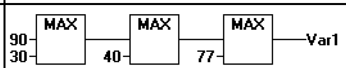
12.4.2 MAX

Maximum function

Returns the greater of two values.

```
OUT := MAX(IN0, IN1)
```

`IN0`, `IN1` and `OUT` can be of any type.

Examples		
IL	**ST**	**FBD**
`LD  90` `MAX 30` `MAX 40` `MAX 77` `ST  Var1     (* Var1 = 90 *)`		

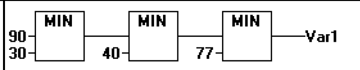
12.4.3 MIN

Minimum function

Returns the lesser of two values.

```
OUT := MIN(IN0, IN1)
```

`IN0`, `IN1` and `OUT` can be of any type.

Examples		
IL	**ST**	**FBD**
`LD   90` `MIN 30` `MIN 40` `MIN 77` `ST   Var1     (* Var1 = 30 *)`		

12.4.4 LIMIT

Limitation

```
OUT := LIMIT(Min, IN, Max)
```

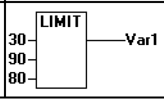
means:

```
OUT := MIN (MAX (IN, Min), Max)
```

`Max` is the upper, `Min` the lower limit for the result.

- If the value `IN` exceeds the upper limit `Max`, then **`LIMIT`** returns `Max`.
- If `IN` falls below `Min`, the result is `Min`.

`IN` and `OUT` can be of any type.

Examples		
IL	**ST**	**FBD**
`LD     90` `LIMIT 30,80` `ST     Var1       (* Var1 = 80 *)`		

12.4.5 MUX

Multiplexer

```
OUT := MUX(K, IN0,...,INn)
```

means:

```
OUT := INk.
```

- `IN0`, ... , `INn` and `OUT` can be of any type.
- `K` must be of type **BYTE**, **WORD**, **DWORD**, **SINT**, **USINT**, **INT**, **UINT**, **DINT** or **UDINT**.
- **MUX** selects the `K`th value from a number of values. If `K` is greater than the number of other inputs (`n`), the last value will be passed on (`INn`).

Examples		
IL	**ST**	**FBD**
LD 0 MUX 30,40,50,60,70,80 ST Var1 (* Var1 = 30 *)		

Tip!

For runtime optimization, the system now computes the expression attached to the input side of `INk`. Contrary to this, simulation computes all branches.

12.5 Comparison operators

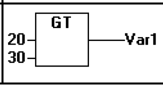
Types:

The operands of the following comparison operators can be of type **BOOL**, **BYTE**, **WORD**, **DWORD**, **SINT**, **USINT**, **INT**, **UINT**, **DINT**, **UDINT**, **REAL**, **TIME**, **DATE**, **TIME_OF_DAY**, **DATE_AND_TIME** and **STRING**.

12.5.1 GT

Greater than

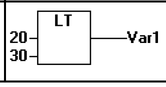
A Boolean operator with the result **TRUE** if the first operand is greater than the second operand.

Examples		
IL	**ST**	**FBD**
LD 20 GT 30 ST Var1 (* Var1 = FALSE *)	Var1 := 20 > 30;	

12.5.2 LT

Less than

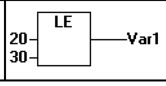
A Boolean operator with the result **TRUE** if the first operand is less than the second operand.

Examples		
IL	**ST**	**FBD**
`LD  20` `LT  30` `ST  Var1     (* Var1 = TRUE *)`	`Var1 := 20 < 30;`	

12.5.3 LE

Less than or equal to

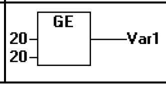
A Boolean operator with the result **TRUE** if the first operand is less than or equal to the second operand.

Examples		
IL	**ST**	**FBD**
`LD  20` `LE  30` `ST  Var1     (* Var1 = TRUE *)`	`Var1 := 20 <= 30;`	

12.5.4 GE

Greater than or equal to

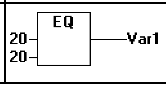
A Boolean operator with the result **TRUE** if the first operand is greater than or equal to the second operand.

Examples		
IL	**ST**	**FBD**
`LD  60` `GE  40` `ST  Var1     (* Var1 = TRUE *)`	`Var1 := 60 >= 40;`	

12.5.5 EQ

Equal to

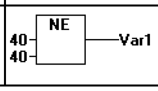
A Boolean operator with the result **TRUE** if the operands are equal to each other.

Examples		
IL	**ST**	**FBD**
`LD  40` `EQ  40` `ST  Var1     (* Var1 = TRUE *)`	`Var1 := 40 = 40;`	

12.5.6 NE

Not equal to

A Boolean operator with the result **TRUE** if the operands are not equal to each other.

Examples		
IL	**ST**	**FBD**
`LD  40` `NE  40` `ST  Var1     (* Var1 = FALSE *)`	`Var1 := 40 <> 40;`	

12.6 Addressing operators

12.6.1 ADR

Addressing function

ADR returns the data memory address of its argument in a **DWORD**. The determined address can be assigned to a pointer within the project.

Examples		
IL	**ST**	**FBD**
LD var1 ADR ST pt		

12.6.2 Contents operator

A pointer is de-referenced by means of the contents operator ^ behind the pointer identifier.

Examples		
IL Declaration	**ST** Declaration	**FBD**
pt:POINTER TO INT; var:int1:INT; vat_int2:INT Implementation LD var_int1 ADR ST pt LD pt^ ST var_int2	pt:POINTER TO INT; var_int1:INT; var_int2:INT; Implementation pt := ADR(var_int1); var_int2:=pt^;	

12.7 Call operator

12.7.1 CAL

Calling up a function block

CAL is used to call up the instance of a function block in IL.

The name of the instance of a function block is followed by the assignment of the input variables of the function block in parentheses.

Example:

Calling up the instance Inst of a function block with the input variables Par1, Par2 set to 0 or **TRUE**.

```
CAL INST(PAR1 := 0, PAR2 := TRUE)
```

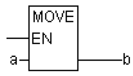
12.8 Assignment operator

12.8.1 MOVE

Assignment operator

The MOVE command is useful only in the LD editor.

If *EN* is TRUE, the content of variable `a` is transferred to variable `b`.

Examples		
IL	ST	LD
		

13 IEC 61131-3 operands

In the DDS, operands can be constants, variables, addresses and function calls.

13.1 Constants

Note!
Not all automation systems support the various different data types.

13.1.1 Number constants

Numerical values can be binary numbers, octal numbers, decimal numbers and hexadecimal numbers.

- If an integer is not a decimal number, its base followed by a hash **#** must be written in front of the integer constant.
- In the case of hexadecimal numbers, the numerical values for numbers 10 to 15 are specified with the letters A-F as is common practice.
- Underscores are not allowed in numerical values with the exception of binary numbers.

Examples:

```
14 (* Decimal number *)
2#1001_0011 (* Binary number *)
8#67 (* Octal number *)
16#A (* Hexadecimal number *)
```

- The type of these numerical values can be: **BYTE**, **WORD**, **DWORD**, **SINT**, **USINT**, **INT**, **UINT**, **DINT**, **UDINT**, **REAL** or **LREAL**.
- Implicit conversions from "higher-" to "lower-order" types are not allowed.
  A **DINT** variable cannot that easily be used as **INT** variable.
  In such cases, use the type conversion functions of the standard library.

13.1.2 BOOL constants

BOOL constants are **TRUE** and **FALSE**. They take up 1 Byte memory.

13.1.3 TIME constants

The DDS allows the declaration of **TIME** constants.

These are specifically used for the timers of the standard library. A **TIME** constant always consists of a leading **t** or **T** (or **time** or **TIME** in full text) and a hash **#**.

This is followed by the actual time declaration that may consist of days (**d**), hours (**h**), minutes (**m**), seconds (**s**) and milliseconds (**ms**).

Note that time specifications must be sorted by size (**d** before **h** before **m** before **s** before **ms**), while not all specifications must occur.

Examples of correct TIME constants in an ST assignment:

```
TIME1 := T#14ms;
TIME1 := T#100s12ms (*Overflow in the highest-order component
 allowed*)
TIME1 := t#12h34m15s;
```

Examples of incorrect TIME constants:

```
TIME1 := t#5m68s; (*Overflow in lower-order component*)
TIME1 := 15ms; (*T# is missing*)
TIME1 := t#4ms13d; (*Wrong sequence of time units*)
```

Maximum size: DWORD 2^{32}-1ms ≈ 49days

13.1.4 DATE constants

Use this type to specify a date.

A **DATE** constant is declared by a leading **d**, **D**, **DATE** or **date** followed by a **#**.

Any year-month-day dates can then be entered.

Examples:

```
DATE#1996-05-06
d#1972-03-29
```

13.1.5 TIME_OF_DAY constants

Use this type to save a time of day.

A **TIME_OF_DAY** declaration starts with **tod#**, **TOD#**, **TIME_OF_DAY#** or **time_of_day#** followed by any hour:minute:second time.

Seconds may be specified as real numbers; fractions of a second are also allowed.

Examples:

```
TIME_OF_DAY#15:36:30.123
tod#00:00:00
```

13.1.6 DATE_AND_TIME-Konstanten

Date constants and time of day may also be combined into so-called **DATE_AND_TIME** constants.

DATE_AND_TIME constants start with **dt#**, **DT#**, **DATE_AND_TIME#** or **date_and_time#**.

Dates are followed by a hyphen and the time of day.

Examples:

```
DATE_AND_TIME#1996-05-06-15:36:30
dt#1972-03-29-00:00:00
```

13.1.7 REAL and LREAL constants

REAL constants may be decimal fractions and exponents

using the American way of decimal points.

Examples:

```
7.4 (* instead of 7,4 *)
1.64e+009 (* instead of 1,64e+009 *)
```

13.1.8 STRING constants

A string can be any character sequence.

STRING constants start and end with single quotes. Umlauts and white spaces are also allowed and processed like any other character.

In character sequences, the combination of the dollar sign **$** followed by two hexadecimal numbers will be interpreted as hexadecimal representation of the 8 bit character code.

Occurrences in a character sequence of combinations of two characters starting with the dollar sign will be interpreted as follows:

$$	Dollar sign
$'	Single quote
$L or **$l**	Line feed
$N or **$n**	New line
$P or **$p**	Page feed
$R or **$r**	Line break
$T or **$t**	Tabulator

Examples:

```
'Hello'
'Susi and Claus'
':-)'
```

13.1.9 Type constants (Typed Literals)

As a rule, IEC constants use the lowest possible data type. If a different data type is to be applied, use Typed Literals without the need of having to explicitly declare the constant.

The constant is given a type-defining prefix.
Notation `<Type>#<Literal>`

- `<Type>` specifies the required data type. The type must be written in uppercase.

  `BOOL, SINT, USINT, BYTE, INT, UINT, WORD, DINT, UDINT, DWORD, REAL, LREAL`

- <Literal> specifies the constant. The input must be compatible with the data type specified under <type>.

  ```
  var1:=DINT#34;
  ```

An error message appears if the constant cannot be transferred into the target type without data loss. Typed literals can be used where normal constants are applied.

13.2 Variables

Variables are declared either locally in the declaration part of an organization unit or in the global variable lists.

- Variables can be used wherever where the declared type allows it.
- The available variables can be called via the Help Manager.

13.2.1 System variable

System variables are implicitly declared variables that depend on the selected automation system and were added to the automation system's PLC configuration.

To find out the automation system's system variable, select the command **Insert→Operand**. In the dialog box *Help Manager* then select category *System variable*.

13.2.2 Access to variables of arrays, structures and organization units

Two-dimensional array components are accessed with the following syntax:

```
<Feldname>[Index1, Index2]
```

Variables of structures are accessed with the following syntax:

```
<Structure name>.<Variable name>
```

Variables of function blocks and programs are accessed with the following syntax:

```
<Organization unit name>.<Variable name>
```

13.2.3 Addressing bits in variables

Integer variables allow individual bits to be addressed. For this purpose, the variable is given an index of the bit to be addressed. The bit index may be given through any constant. Indexing is 0-based.

```
a : INT;
b : BOOL;
...
a.2 := b;
```

The third bit of variable a is set to the value of variable b. The following error message is output if the index is greater than the variable's bit width:
Index '<n>' outside the range valid for variable '<var>'!

The following variable types allow bit addressing.

```
SINT, INT, DINT, USINT, UINT, UDINT, BYTE, WORD, DWORD
```

The following error message is output if the variable type is not permitted.
Bit access must not be assigned to a VAR_IN_OUT variable!

13.2.4 Identifiers

An identifier is a sequence of letters, numbers and underscores starting with a letter or an underscore.

Variable identifiers must not:

- contain white spaces and umlauts,
- be declared twice,
- be identical to keywords.

Furthermore:

- Case sensitivity is **not** an option for variables.
  (Example: `VAR1`, `Var1` and `var1` are not different variables)
- Underscores in an identifier are significant.
  (Example: `A_BCD` and `AB_CD` are interpreted as different identifiers.)
- Multiple successive underscores at the beginning of or within an identifier are **not** allowed.
- The first 32 characters are significant.

13.3 Addresses

13.3.1 Address

For a declaration, variables can be assigned to a physical memory location (PLC address) by means of the keyword **`AT`**.

The address specification structure is established with the help of special character lines.

The character sequence starts with a "`%`" followed by a range prefix and a prefix (data type) for the size. It ends with a sequence of numbers that specify the direct memory location.

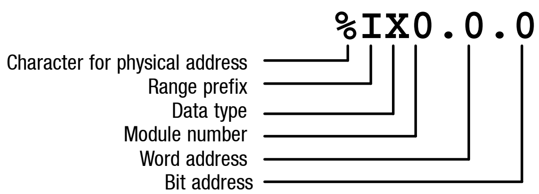
The following range prefixes are supported:

`I`	Input
`Q`	Output
`M`	Flag (internal memory)

The following size prefixes are supported:

`X`	Single bit
`None`	Optional
`B`	Byte (8 bits)
`W`	Word (16 bits)
`D`	Double word (32 bits)

Inputs/outputs:

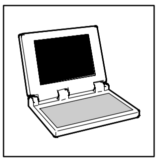


Module number

The module number specifies the automation system module (system organization unit) to be approached.

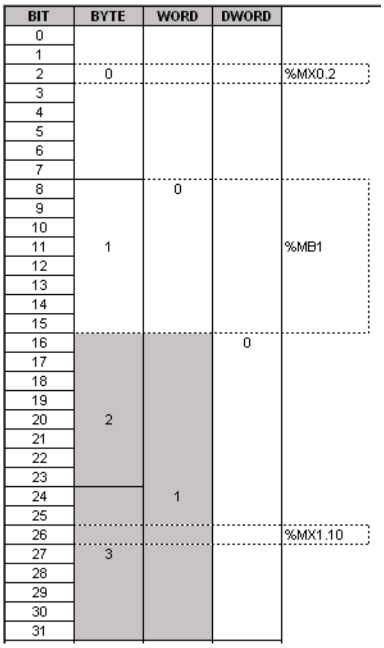
Examples:

```
%QX0.0.2    Output bit 2
%IW0.0.1    Input bit 1
%MB7        Flag byte 7
%MW1        Flag word 1
%MD3        Flag double word 3
%MX1.2      Third flag bit in flag word 1
```



Memory/Address Manager

The memory is divided into words, with a word being made up of 16 bits (bit0 to bit15).
The table below illustrates the memory data structure:



Note!

Boolean values are assigned byte-by-byte unless a single bit address is explicitly specified. A value change of varbool1 AT%MW0 affects the range from %MX0.0 to %MX0.7

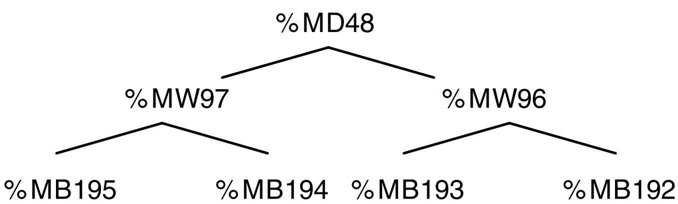
13.3.2 Flags

Tip!

The flag range size is dependent on the selected automation system.

Example1:

```
%MD48
```



addresses bytes nos. 192, 193, 194 and 195 (48 * 4 = 192) in the flag range.
The first byte is byte no. 0.

Example2:

```
%MX5.0
```

addresses the first bit in the fifth word in the flag range.
(Bits are generally saved word by word.)

13.4 Function calls

In ST, a function call can also be an operand.

Example:

```
Result := Fct(7) + 3;
```

14 IEC 61131-3 standard functions

Type conversion functions	
Conversions between integer number types.	
BOOL_TO	BOOL → type X
TO_BOOL	Type X → BOOL
TIME_TO / TIME_OF_DAY	TIME / TIME_OF_DAY → type X
DATE_TO / DT_TO	DATE / DATE_AND_TIME → type X
STRING_TO	STRING → type X
TRUNC	REAL → INT
Numerical functions	
ABS	Absolute value
SQRT	Square root
LN	Natural logarithm
LOG	Logarithm to the base of 10
EXP	Exponential function
SIN	Sine calculation in radians
COS	Cosine calculation in radians
TAN	Tangent calculation in radians
ASIN	Arc sine calculation in radians
ACOS	Arc cosine calculation in radians
ATAN	Arc tangent calculation in radians
EXPT	Exponentiation of one variable to another
STRING functions	
LEN	Returns the length of a string
LEFT	Returns a left start string of a string
RIGHT	Returns a right start string of a string
MID	Returns a segment of a string
CONCAT	Concatenates two strings
INSERT	Inserts a string into another string from a specific position
DELETE	Deletes a segment from a string from a specific position
REPLACE	Replaces a segment within a string with another string
FIND	Looks for a segment within a string
Bistable function blocks	
SR	Bistable function block (dominant set)
RS	Bistable function block (dominant reset)
SEMA	Software semaphore (interruptible)
Edge detection	
R_TRIG	Rising edge detector
F_TRIG	Falling edge detector
Counters	
CTU	Up counter
CTD	Down counter
CTUD	Up and down counter
Timers	
TP	Pulse encoder
TON	Timer on-delay
TOF	Timer off-delay
RTC*	Runtime clock*
* Not supported	

14.1 Type conversion functions

Implicit conversions from a "higher-" type to a "lower-order" type are not permitted (such as from **INT** to **BYTE** or from **DINT** to **WORD**). Special type conversion functions must be applied to do so.

Conversions from any elementary type to any other elementary type are possible on principle.

Syntax:

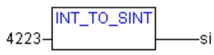
```
<elem.type1>_TO_<elem.type2>
```

14.1.1 Converting between integer number types

Conversion from an integer number type to another number type

Conversion from higher- to lower-order types may result in information loss.

- Where the number to be converted exceeds the range limit, the first bytes of the number will not be considered.

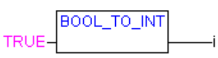
Examples		
IL	**ST**	**FBD**
LD 4223 INT_TO_SINI ST si	si:=INT_TO_SINT(4223); (* si=127 *)	

If the integer 4223 (16#107f in hexadecimal writing) is saved as **SINT** variable, that variable will be assigned the number 127 (16#7f in hexadecimal writing).

14.1.2 BOOL_TO

Converting BOOL into another type

- With number types, the result is 1 if the operand is **TRUE**, and 0 if the operand is **FALSE**.
- With type **STRING**, the result is **TRUE** or **FALSE**.

Examples		
IL		
LD TRUE BOOL_TO_INT ST i	LD TRUE BOOL_TO_STRING ST str	LD TRUE BOOL_TO_TIME ST t
LD TRUE BOOL_TO_TOD ST tof1	LD FALSE BOOL_TO_DATE ST dat	LD TRUE BOOL_TO_DT ST dandt
ST		
i:=BOOL_TO_INT(TRUE); str:=BOOL_TO_STRING(TRUE); t:=BOOL_TO_TIME(TRUE); tof1:=BOOL_TO_TOD(TRUE); dat:=BOOL_TO_DATE(FALSE); dandt:=BOOL_TO_DT(TRUE);	(* i=1 *) (* str='TRUE' *) (* t=T#1ms *) (* tof=TOD#00:00:00.001 *) (* dat=D#1970-01-01 *) (* dandt=DT#1970-01-01-00:00:01 *)	
FBD		
 		

14.1.3 TO_BOOL

Converting from any type to BOOL

- The result is **TRUE** if the operand is not 0 and **FALSE** if the operand is 0.
- With type **STRING** the result is **TRUE** if the operand is **TRUE**, otherwise the result is **FALSE**.

Examples

IL

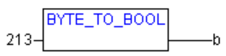
```
LD 213                          LD 0                             LD T#5ms
BYTE_TO_BOOL                    INT_TO_BOOL                      TIME_TO_BOOL
ST b (* b=TRUE *)               ST b (* b=FALSE *)               ST b (* b=TRUE *)

LD 'TRUE'
STRING_TO_BOOL
ST b (* b=TRUE *)
```

ST

```
b:=BYTE_TO_BOOL(2#11010101);    (* b=TRUE *)
b:=INT_TO_BOOL(0);              (* b=FALSE *)
b:=TIME_TO_BOOL(T#5ms);         (* b=TRUE *)
b:=STRING_TO_BOOL('TRUE');      (* b=TRUE *)
```

FBD



14.1.4 TIME_TO / TIME_OF_DAY

Converting from TIME or TIME_OF_DAY to another type

Internally, the time is saved as a **DWORD** in milliseconds (with **TIME_OF_DAY** from 00:00 o'clock). This value is converted.

- With type **STRING**, the result is the time constant.
- Conversion from higher- to lower-order types may result in information loss.

Examples

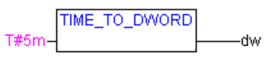
IL

```
LD T#12ms                       LD T#300000ms                    LD TOD#00:00:00.012
TIME_TO_STRING                  TIME_TO_DWORD                    TOD_TO_SINT
ST str                          ST dw                            ST si
```

ST

```
str:=TIME_TO_STRING(T#12ms);                              (* str='T#12ms' *)
dw:=TIME_TO_DWORD(T#5m);                                  (* dw=300000 *)
si:=TOD_TO_SINT(TOD#00:00:00.012);                        (* si=12 *)
```

FBD



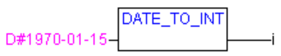
14.1.5 DATE_TO / DT_TO

Converting from type DATE or DATE_AND_TIME to another type

Internally, the date is saved in a **DWORD** in seconds since the 1st of January 1970. This value is converted.

- With type **STRING**, the result is a date constant.
- Conversion from higher- to lower-order types may result in information loss.

Examples		
IL		
LD D#1970-01-01 DATE_TO_BOOL ST b	LD D#1970-01-15 DATE_TO_INT ST i	LD DT#1970-01-15-05:05:05 DT_TO_BYTE ST byt
LD DT#1998-02-13-14:20 DT_TO_STRING ST str		
ST		
b:=DATE_TO_BOOL(D#1970-01-01); i:=DATE_TO_INT(D#1970-01-15); byt:=DT_TO_BYTE(DT#1970-01-15-05:05:05); str:=DT_TO_STRING(DT#1998-02-13-14:20);		(* b=FALSE *) (* i=29952 *) (* byt=129 *) (* str= 'DT#1998-02-13-14:20' *)
FBD		



14.1.6 STRING_TO

Converting STRING into another type

The operand of type **STRING** must have a valid target type value as otherwise the result will be 0.

Examples		
IL		
LD 'TRUE' STRING_TO_BOOL ST b	LD '123' STRING_TO_WORD ST w	LD 't#127ms' STRING_TO_TIME ST t
ST		
b:=STRING_TO_BOOL('TRUE'); w:=STRING_TO_WORD('123'); t:=STRING_TO_TIME('T#127ms');		(* b=TRUE *) (* w=123 *) (* t=T#127ms *)

14.1.7 TRUNC

Converting from REAL to type INT

- Conversion uses the integer component of the floating-point number.
- Conversion from higher- to lower-order types may result in information loss.

Examples		
IL		**ST**
LD 1.9 TRUNC ST i (* i=1 *)	LD -1.4 TRUNC ST i (* i=-1 *)	i:=TRUNC(1.9); i:=TRUNC(-1.4);

14.2 Numerical functions

14.2.1 ABS

Returns the absolute value of a number

Examples		
IL	**ST**	**FBD**
LD -2 ABS ST i (* i=2 *)	i:=ABS(-2);	

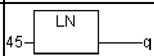
14.2.2 SQRT

Returns the square root of a number

Examples		
IL	**ST**	**FBD**
LD 16 SQRT ST q (* q=4 *)	q:=SQRT(16);	

14.2.3 LN

Returns the natural logarithm of a number

Examples		
IL	**ST**	**FBD**
LD 45 LN ST q (* q=3.806663 *)	q:=LN(45);	

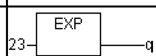
14.2.4 LOG

Returns the logarithm to the base of 10 of a number

Examples		
IL	**ST**	**FBD**
LD 314.5 LOG ST q (* q=2.497621 *)	q:=LOG(314.5);	

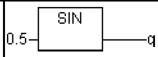
14.2.5 EXP

Returns the exponential function

Examples		
IL	**ST**	**FBD**
LD 23 EXP ST q (* q=9.744791e+009 *)	q:=EXP(23);	

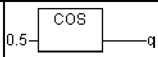
14.2.6 SIN

Returns the sine of a number in radians

Examples		
IL	**ST**	**FBD**
`LD 0.5` `SIN` `ST q (* q=0.4794255 *)`	`q:=SIN(0.5);`	

14.2.7 COS

Returns the cosine of a number in radians

Examples		
IL	**ST**	**FBD**
`LD 0.5` `COS` `ST q (* q=0.8775826 *)`	`q:=COS(0.5);`	

14.2.8 TAN

Returns the tangent of a number in radians

Examples		
IL	**ST**	**FBD**
`LD 0.5` `TAN` `ST q (* q=0.5463024 *)`	`q:=TAN(0.5);`	

14.2.9 ASIN

Returns the arc sine (inversion of sine) of a number in radians

Examples		
IL	**ST**	**FBD**
`LD 0.5` `ASIN` `ST q (* q=0.5235988 *)`	`q:=ASIN(0.5);`	

14.2.10 ACOS

Returns the arc cosine (inversion of cosine) of a number in radians

Examples		
IL	**ST**	**FBD**
`LD 0.5` `ACOS` `ST q (* q=1.047198 *)`	`q:=ACOS(0.5);`	

14.2.11 ATAN

Returns the arc tangent (inversion of tangent) of a number in radians

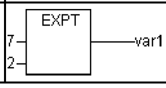
Examples		
IL	**ST**	**FBD**
`LD 0.5` `ATAN` `ST q (* q=0.4636476 *)`	`q:=ATAN(0.5);`	

14.2.12 EXPT

Exponentiation of one variable with another:

$$OUT = IN1^{IN2}$$

- `OUT` is of type **`REAL`**.
- `IN1` and `IN2` can be of type **`BYTE`**, **`WORD`**, **`DWORD`**, **`INT`**, **`DINT`**, **`REAL`**.

Examples		
IL	**ST**	**FBD**
`LD 7` `EXPT 2` `ST var1 (* var1=49 *)`	`var1:=EXPT(7,2);`	

14.3 STRING functions

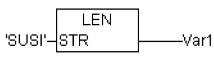
Note!

The permissible string length is dependent on the applied automation system.
If the length is exceeded, an error message will be displayed in online mode.

14.3.1 LEN

Returns the length of a string

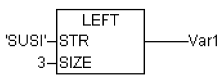
- `STR` is of type **`STRING`**, the return value of the function type **`INT`**.

Examples		
IL	**ST**	**FBD**
`LD 'SUSI'` `LEN` `ST Var1 (* Var1=4 *)`	`Var1:=LEN('SUSI');`	

14.3.2 LEFT

Returns a left start string of a string

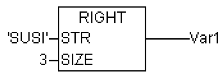
- `STR` is of type **`STRING`**, `SIZE of` type **`INT`**, the return value of the function type **`STRING`**.
- `LEFT(STR,SIZE)` means: Take the first `SIZE` characters from the left in the string `STR`.

Examples		
IL	**ST**	**FBD**
`LD 'SUSI'` `LEFT 3` `ST Var1 (* Var1='SUS' *)`	`Var1:=LEFT('SUSI',3);`	

14.3.3 RIGHT

Returns a right start string of a string

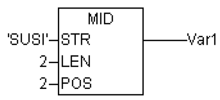
- `STR` is of type **`STRING`**, `SIZE` of type **`INT`**, the return value of the function type **`STRING`**.
- `RIGHT (STR, SIZE)` means: Take the first `SIZE` characters from the right in the string `STR`.

Examples		
IL	**ST**	**FBD**
`LD 'SUSI'` `RIGHT 3` `ST Var1 (* Var1='USI' *)`	`Var1:=RIGHT('SUSI',3);`	

14.3.4 MID

Returns a segment of a string

- `STR` is of type **`STRING`**, `LEN` and `POS` of type **`INT`**, the return value of the function type **`STRING`**.
- `MID (STR, LEN, POS)` means: Get `LEN` characters from the string `STR` starting with the character at `POS`.

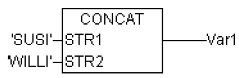
Examples		
IL	**ST**	**FBD**
`LD 'SUSI'` `MID 2,2` `ST Var1 (* Var1='US' *)`	`Var1:=MID('SUSI',2,2);`	

14.3.5 CONCAT

Concatenation

Concatenating two strings

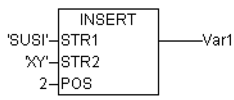
- `STR1`, `STR2` and the return value of the function are of type **`STRING`**.

Examples		
IL	**ST**	**FBD**
`LD 'SUSI'` `CONCAT 'WILLI'` `ST Var1` `(* Var1='SUSIWILLI' *)`	`Var1:=CONCAT` `('SUSI','WILLI');`	

14.3.6 INSERT

Inserts a string into another string from a specific position

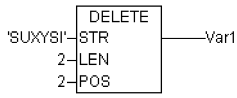
- `STR1` and `STR2` are of type **`STRING`**, `POS` of type **`INT`**, the return value of the function type **`STRING`**.
- `INSERT(STR1, STR2, POS)` means: Insert `STR2` into `STR1` after the `POS`-th position.

Examples		
IL	**ST**	**FBD**
`LD 'SUSI'` `INSERT 'XY',2` `ST Var1` `(* Var1='SUXYSI' *)`	`Var1 := INSERT` `('SUSI','XY',2);`	

14.3.7 DELETE

Deletes a segment from a string from a specific position

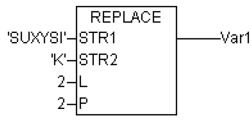
- `STR1` is of type **`STRING`**, `LEN` and `POS` of type **`INT`**, the return value of the function type **`STRING`**.
- `DELETE(STR, L, P)` means: Delete `L` characters from `STR`, starting with the `P` th.

Examples		
IL	**ST**	**FBD**
LD 'SUXYSI' DELETE 2,2 ST Var1 (* Var1='SUSI' *)	Var1:=DELETE ('SUXYSI',2,2);	

14.3.8 REPLACE

Replaces a segment within a string with another string

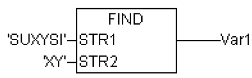
- `STR1` and `STR2` are of type **`STRING`**, `LEN` and `POS` of type **`INT`**, the return value of the function type **`STRING`**.
- `REPLACE(STR1, STR2, L, P)` means: Replace `L` characters from `STR1` with `STR2` starting with the `P`-th character.

Examples		
IL	**ST**	**FBD**
LD 'SUXYSI' REPLACE 'K',2,2 ST Var1 (* Var1='SKYSI' *)	Var1:=REPLACE ('SUXYSI','K',2,2);	

14.3.9 FIND

Looks for a segment within a string

- `STR1` and `STR2` are of type **`STRING`**, the return value of the function type **`INT`**.
- `FIND (STR1, STR2)` means: Find the position of the first character of the first occurrence of `STR2` in `STR1`.
- If `STR2` does not occur in `STR1` , the return value will be :=0.

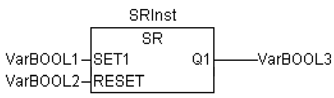
Examples		
IL	**ST**	**FBD**
LD 'SUXYSI' FIND 'XY' ST Var1 (* Var1=3 *)	Var1:=FIND('SUXYSI','XY');	

14.4 Bistable function blocks

14.4.1 SR

Bistable function block (dominant set)

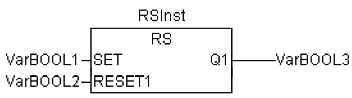
- `Q1`, `SET1` and `RESET` are of type **`BOOL`**.
- `Q1 = SR (SET1, RESET)` means: `Q1 = (NOT RESET AND Q1) OR SET1`

<table>
<tr><th colspan="2">Examples</th></tr>
<tr><td colspan="2">Declaration:</td></tr>
<tr><td colspan="2"><code>SRInst : SR;</code></td></tr>
<tr><td>IL
<code>CAL SRInst(SET1:=VarBOOL1, RESET:=VarBOOL2)</code>
<code>LD SRInst.Q1</code>
<code>ST VarBOOL3</code></td><td rowspan="2">FBD

</td></tr>
<tr><td>ST
<code>SRInst(SET1:=VarBOOL1, RESET:=VarBOOL2);</code>
<code>VarBOOL3:=SRInst.Q1;</code></td></tr>
</table>

14.4.2 RS

Bistable function block (dominant reset)

- `Q1`, `SET` and `RESET1` are of type **`BOOL`**.
- `Q1 = RS (SET, RESET1)` means: `Q1 = NOT RESET1 AND (Q1 OR SET)`

<table>
<tr><th colspan="2">Examples</th></tr>
<tr><td colspan="2">Declaration:</td></tr>
<tr><td colspan="2"><code>RSInst : RS;</code></td></tr>
<tr><td>IL
<code>CAL RSInst(SET:=VarBOOL1, RESET1:=VarBOOL2)</code>
<code>LD RSInst.Q1</code>
<code>ST VarBOOL3</code></td><td rowspan="2">FBD

</td></tr>
<tr><td>ST
<code>RSInst(SET:=VarBOOL1, RESET1:=VarBOOL2);</code>
<code>VarBOOL3:=RSInst.Q1;</code></td></tr>
</table>

14.4.3 SEMA

Software semaphore (interruptible)

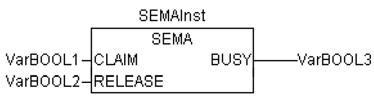
`X` is an internal **`BOOL`** variable initialized with **`FALSE`** .

`BUSY`, `CLAIM` and `RELEASE` are of type **`BOOL`**.

- If `SEMA` is called and `BUSY` is **`TRUE`**, `SEMA` has already been assigned (`SEMA` was called using `CLAIM` = **`TRUE`**).
- If `BUSY` **`is FALSE`**, `SEMA` has either not been called yet or been enabled (call with `RELEASE` = **`TRUE`**).

`BUSY = SEMA(CLAIM, RELEASE)` means:

```
BUSY:=X;
IF CLAIM THEN X:=TRUE;
ELSIF RELEASE THEN BUSY:=FALSE; X:=FALSE;
END_IF
```

<table>
<tr><td colspan="2">Examples</td></tr>
<tr><td colspan="2">Declaration:</td></tr>
<tr><td colspan="2"><code>SEMAInst : SEMA;</code></td></tr>
<tr><td>IL
<code>CAL SEMAInst(CLAIM:=VarBOOL1, RELEASE:=VarBOOL2)</code>
<code>LD SEMAInst.BUSY</code>
<code>ST VarBOOL3</code></td><td rowspan="2">FBD

</td></tr>
<tr><td>ST
<code>SEMAInst(CLAIM:=VarBOOL1, RELEASE:=VarBOOL2);</code>
<code>VarBOOL3:=SEMAInst.BUSY;</code></td></tr>
</table>

14.5 Edge detection

14.5.1 R_TRIG

Rising edge detector

```
FUNCTION_BLOCK R_TRIG
VAR_INPUT
 CLK : BOOL;
END_VAR
VAR_OUTPUT
 Q : BOOL;
END_VAR
VAR
 M : BOOL := FALSE;
END_VAR
 Q := CLK AND NOT M;
 M := CLK1;
END_FUNCTION_BLOCK
```

As long as the input variable `CLK` **`is FALSE`**,
the output `Q` and the auxiliary variable `M` **`will be FALSE`** .

As soon as `CLK` **`returns TRUE`**,
`Q will first return` **`TRUE`** and then `M` will be switched to **`TRUE`** .

I.e.: with every subsequent function call, `Q` will return **`FALSE`** until `CLK` has a falling and another rising edge.

<table>
<tr><td colspan="2">Examples</td></tr>
<tr><td colspan="2">Declaration:</td></tr>
<tr><td colspan="2">RTRIGInst : R_TRIG;</td></tr>
<tr><td>IL
CAL RTRIGInst(CLK:=VarBOOL1)
LD RTRIGInst.Q
ST VarBOOL2</td><td rowspan="2">FBD
</td></tr>
<tr><td>ST
RTRIGInst(CLK:=VarBOOL1);
VarBOOL2:=RTRIGInst.Q;</td></tr>
</table>

14.5.2 F_TRIG

Falling edge detector

```
FUNCTION_BLOCK F_TRIG
VAR_INPUT
 CLK : BOOL;
END_VAR
VAR_OUTPUT
 Q : BOOL;
END_VAR
VAR
 M : BOOL := TRUE;
END_VAR
 Q := NOT CLK AND NOT M;
 M := NOT CLK;
END_FUNCTION_BLOCK
```

As long as the input variable `CLK` **`returns TRUE`**,
the output `Q` and the auxiliary variable `M` **`will be FALSE`**.

As soon as `S1` **`is FALSE`**, `Q will first return` **`TRUE`** and then `M` will be switched to **`TRUE`**.

I.e.: with every subsequent function call,
`Q` will return **`FALSE`** until `CLK` has a rising and another falling edge.

<table>
<tr><td colspan="2">Examples</td></tr>
<tr><td colspan="2">Declaration:</td></tr>
<tr><td colspan="2">FTRIGInst : F_TRIG;</td></tr>
<tr><td>IL
CAL FTRIGInst(CLK:=VarBOOL1)
LD FTRIGInst.Q
ST VarBOOL2</td><td rowspan="2">FBD

</td></tr>
<tr><td>ST
FTRIGInst(CLK:=VarBOOL1);
VarBOOL2:=FTRIGInst.Q;</td></tr>
</table>

14.6 Counters

14.6.1 CTU

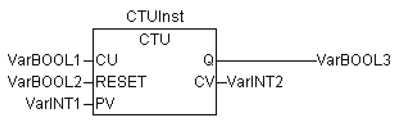
Up counter

`CU`, `RESET` and `Q` are of type **`BOOL`**, `PV` and `CV` are of type **`INT`**.

- If `RESET is` **`TRUE`**, the counter variable `CV` is set to 0.
- Every positive edge at input *CU increases CV* by 1.
  As long as *CV* is less than *PV* max (i.e. no overflow).
- `Q` returns **`TRUE`** if `CV` is greater than or equal to the upper limit `PV` .

`CTU(CU, RESET, PV, Q, CV)` means:

- If `RESET is TRUE`, the counter variable `CV` will be initialized with 0.
- If `CU` has a rising edge, `CV` will be increased by 1.

<table>
<tr><td colspan="2">Examples</td></tr>
<tr><td colspan="2">Declaration:</td></tr>
<tr><td colspan="2"><code>CTUInst : CTU;</code></td></tr>
<tr><td>IL
<code>CAL CTUInst(CU:=VarBOOL1, RESET:=VarBOOL2, PV:=VarINT1)</code>
<code>LD CTUInst.Q</code>
<code>ST VarBOOL3</code>
<code>LD CTUInst.CV</code>
<code>ST VarINT2</code></td><td rowspan="2">FBD

</td></tr>
<tr><td>ST
<code>CTUInst(CU:=VarBOOL1, RESET:=VarBOOL2, PV:=VarINT1);</code>
<code>VarBOOL3:=CTUInst.Q;</code>
<code>VarINT2:=CTUInst.CV;</code></td></tr>
</table>

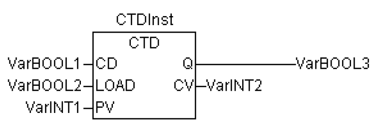
14.6.2 CTD

Down counter

`CD`, `LOAD` and `Q` are of type **`BOOL`**, `PV` and `CV` are of type **`INT`**.

- If `LOAD is` **`TRUE`**, the counter variable `CV` will be set equal to the upper limit `PV`.
- If `LOAD` **`is FALSE`**, every function block call `will decrease CV` by 1.
- `Q` returns **`TRUE`** if `CV` is less than or equal to 0.

`CTD(CD, LOAD, PV, Q, CV)`

<table>
<tr><td colspan="2">Examples</td></tr>
<tr><td colspan="2">Declaration:</td></tr>
<tr><td colspan="2"><code>CTDInst : CTD;</code></td></tr>
<tr><td>IL
<code>CAL CTDInst(CD:=VarBOOL1, LOAD:=VarBOOL2, PV:=VarINT1)</code>
<code>LD CTDInst.Q</code>
<code>ST VarBOOL3</code>
<code>LD CTDInst.CV</code>
<code>ST VarINT2</code></td><td rowspan="2">FBD

</td></tr>
<tr><td>ST
<code>CTUInst(CD:=VarBOOL1, LOAD:=VarBOOL2, PV:=VarINT1);</code>
<code>VarBOOL3:=CTDInst.Q;</code>
<code>VarINT2:=CTDInst.CV;</code></td></tr>
</table>

14.6.3 CTUD

Up and down counter

`CU`, `CD`, `RESET`, `LOAD`, `QU` and `QD` are of type **`BOOL`**, `PV` and `CV` are of type **`INT`**.

- If `RESET` is valid, the counter variable `CV` will be initialized with 0.
- If `LOAD` is valid, `CV` will be initialized with `PV` .
- If positive edge `CU` is valid, `CV` will be increased by 1 as long as `CV` does not cause an overflow.
- If positive edge `CD` is valid, `CV` will be decreased by 1 as long as `CV` does not cause an underflow.
- `QU` returns **`TRUE`** if `CV` has become greater than or equal to `PV`.
- `QD` returns **`TRUE`**if `CV` has become less than or equal to 0.

`CTUD(CU, CD, RESET, LOAD, PV, QU, QD, CV)`

Examples

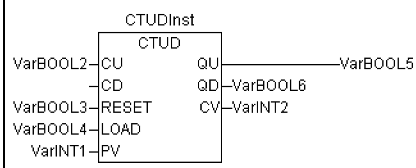
Declaration:

```
CTUDInst : CTUD;
```

IL

```
CAL CTUDInst(CU:=VarBOOL2, RESET:=VarBOOL32,
 LOAD:=VarBOOL4; PV:=VarINT1)
LD CTUDInst.QU
ST VarBOOL5
LD CTUDInst.QD
ST VarBOOL6
LD CTUDInst.CV
ST VarINT2
```

FBD



ST

```
CTUDInst(CU:=VarBOOL2, RESET:=VarBOOL32, LOAD:=VarBOOL4; PV:=VarINT1);
VarBOOL5:=CTUDInst.QU;
VarBOOL6:=CTUDInst.QD;
VarINT2:=CTUDInst.CV;
```

14.7 Timers

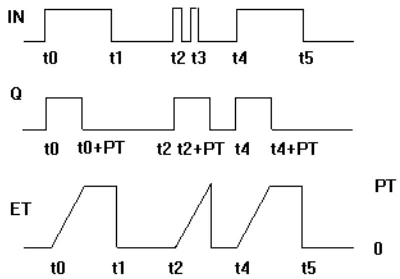
14.7.1 TP

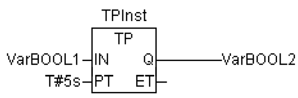
Pulse encoder

`TP(IN, PT, Q, ET)` means:

- `IN` and `PT` are input variables of type **`BOOL`** or **`TIME`**.
- `Q` and `ET` are output variables of type **`BOOL`** or **`TIME`**.
- After a positive edge at input `IN`, output `Q` becomes TRUE for the time specified at `PT` Then `Q` will be **`FALSE again`**.
- As soon as `IN` **`returns TRUE`**, `ET` will count the time in milliseconds until the value equals that in `PT` and then remain the same.
- `Q` thus returns a signal for the time specified at `PT` .

Graphic representation of TP's time sequence:



<table>
<tr><td colspan="2">Examples</td></tr>
<tr><td colspan="2">Declaration:</td></tr>
<tr><td colspan="2"><code>TPInst : TP;</code></td></tr>
<tr><td>IL
<code>CAL TPInst(IN:=VarBOOL1, PT:=T#5s)</code>
<code>LD TPInst.Q</code>
<code>ST VarBOOL2</code></td><td rowspan="2">FBD

</td></tr>
<tr><td>ST
<code>TPInst(IN:=VarBOOL1, PT:=T#5s);</code>
<code>VarBOOL2:=TPInst.Q;</code></td></tr>
</table>

14.7.2 TON

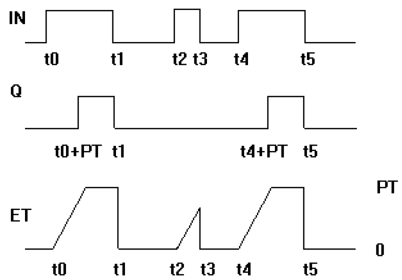
Timer on-delay

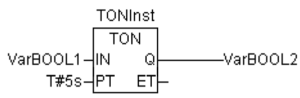
`TON(IN, PT, Q, ET)` means:

- `IN` and `PT` are input variables of type **`BOOL`** or **`TIME`**.
- `Q` and `ET` are output variables of type **`BOOL`** or **`TIME`**.
- If `IN` **`is FALSE`**, the returns are **`FALSE`** or 0.
- As soon as `IN` **`returns TRUE`**, `ET` will count the time in milliseconds until the value equals that in `PT` and then remain the same.
- `Q` is **`TRUE`** if `IN` **`returns TRUE`** and `ET` equals `PT`. Otherwise `Q` **`will be FALSE`**.

`Q` thus has a rising edge when the time set in milliseconds in `PT` has expired.

Graphic representation of TON's time sequence:



<table>
<tr><td colspan="2">Examples</td></tr>
<tr><td colspan="2">Declaration:</td></tr>
<tr><td colspan="2"><code>TONInst : TON;</code></td></tr>
<tr><td>IL
<code>CAL TONInst(IN:=VarBOOL1, PT:=T#5s)</code>
<code>LD TONInst.Q</code>
<code>ST VarBOOL2</code></td><td rowspan="2">FBD
</td></tr>
<tr><td>ST
<code>TONInst(IN:=VarBOOL1, PT:=T#5s);</code>
<code>VarBOOL2:=TONInst.Q;</code></td></tr>
</table>

14.7.3 TOF

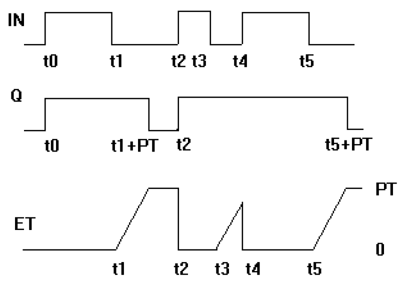
Timer off-delay

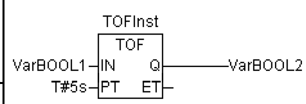
`TOF(IN, PT, Q, ET)` means:

- `IN` and `PT` are input variables of type **`BOOL`** or **`TIME`**.
- `Q` and `ET` are output variables of type **`BOOL`** or **`TIME`**.
- As soon as `IN` **`is FALSE`**, `ET` will count the time in milliseconds until the value equals that in `PT` and then remain the same.
- `Q` is **`FALSE`** if `IN` **`is FALSE`** and `ET` equals `PT`. Otherwise `Q` **`returns TRUE`**.

`Q` thus has a falling edge when the time set in milliseconds in `PT` has expired.

Graphic representation of TOF's time sequence:



<table>
<tr><th colspan="2">Examples</th></tr>
<tr><td colspan="2">Declaration:</td></tr>
<tr><td colspan="2"><code>TOFInst : TOF;</code></td></tr>
<tr><td>IL
<code>CAL TOFInst(IN:=VarBOOL1, PT:=T#5s)</code>
<code>LD TOFInst.Q</code>
<code>ST VarBOOL2</code></td><td rowspan="2">FBD

</td></tr>
<tr><td>ST
<code>TOFInst(IN:=VarBOOL1, PT:=T#5s);</code>
<code>VarBOOL2:=TOFInst.Q;</code></td></tr>
</table>

15 Appendix

15.1 Command line commands

The DDS can be assigned certain commands on startup that will become effective on program execution. These command line commands start with "/" and are case-insensitive. Processing is sequential from left to right.

/online	DDS attempts to go online with the current project after startup.
/run	DDS starts the user program after log-in. Valid in combination with /online only.
/show /show hide /show icon /show max /show normal	The DDS frame window display can be set. The window is not displayed and does not show in the task bar. The window is minimized. The window is maximized. The window is shown in the status applicable on last exit.
/out <outfile>	All messages are output into the message window and the file <outfile>.
/cmd <cmdfile>	After startup, the commands in command file <cmdfile> will be executed.

A command line input is structured as follows:
"<DDS EXE file path>" "<Project path>" / <Command 1> / <Command 2> ...

DDS file *.pro is opened, the window is not displayed. The content of command file (cmdfile) command.cmd is processed.

15.2 Command file (Cmdfile) commands

The commands that may be used within a command file **<cmdfile>** are listed as follows. The file can then be called via the command line (see above). Input is case-insensitive.The command line is output as a message in the message window in the message file (see below), preceded, in addition to the command, by an " @". All characters behind a semicolon (;) are ignored (comment). Any white spaces in parameters require the respective parameters to be put in quotes.

Online menu commands	
online login	Log in with the loaded project **Online→Log in**
online logout	Log out **Online→Log out**
online run	Start the user program **Online→Log in**
online sim	Activate simulation (✓) **Online →Log in**
online sim off	Deactivate simulation **Online→Simulation**

Menu File commands	
file new	Create a new project **File→New**
file open <projectfile>	Load the specified project **File→Open**
file close	Close the loaded project. **File →Close**
file save	Save the loaded project **File→Save**
file saveas <projectfile>	Save the loaded project under the specified name **File→Save as**
file quit	Exit DDS **File →Exit**

Menu Project commands	
project compile or project build	Incrementally compile the loaded project **Project→Compile**
project rebuild	Completely compile the loaded project **Project→Compile all**
project clean	Deletes compile and download information in the current project **Project →Clean all**
project import <file 1> ... <file n>	Import the specified files <file1> ... <file n> into the loaded project **Project→Import**
project export <expfile>	Export the loaded project into the specified file <expfile> **Project→Export**
project expmul <dir>	Export every object of the loaded project into the directory <dir> into a separate file, each bearing the object's name.

Manage message file	
out open <msgfile>	Open the specified file for message output. New messages will be attached
out close	Close the currently open message file
out clear	Clear all messages from the currently open message file

Manage message output	
echo on	Also output command lines as message
echo off	Do not output command lines as message
echo <text>	Output the <text> as message

Manage the replacement of objects or files during Import, Export, Replace	
replace ok replace yes	Replace
replace no	Do not replace
replace yesall	Replace all
replace noall	Replace none

Manage the default behaviour of DDS dialogs	
query on	Display dialogs expecting user input
query of ok	All dialogs behave in accordance with a click on **OK**
query off no	All dialogs behave in accordance with a click on **No**
query off cancel	All dialogs behave in accordance with a click on **Cancel**

Command to call command files as subroutines	
call <parameter 1> ... <parameter 10>	Call command files as subroutines. Up to 10 parameters may be transferred. In the called file, $0 - $9 may be used to access the parameters.

Set used DDS directories	
dir lib <libdir>	Set <libdir> as the library directory
dir compile <compiledir>	Set <compiledir> as compilation file directory

Delay CMDFILE processing	
delay 5000	Wait 5 seconds (accuracy of execution in 100ms steps)

Manage the Watch and Receipt Manager	
watchlist load <file>	Loads the Watch list saved under <file> and opens the associated window **Extras→Load Watch list**
watchlist save <file>	Saves the current Watch list under<file> **Extras→Save Watch list**
watchlist set <text>	Assign the name <text> to a previously loaded Watch list **Extras→Rename Watch list**
watchlist read	Update the Watch variable values **Extras→Read Receipt**
watchlist write	Assign the Watch variables with the values in the Watch list **Extras→Write Receipt**

Integrate libraries	
library add <libraryfile 1> <libraryfile 2> ... <libraryfile n>	Attach the specified library files to the library list of the currently open project. If the file path is relative, the library directory set in the project will be set as the path root.
library delete [<library 1> <library 2> ... <library n>]	Delete all libraries or the specified one from the library list of the currently open project.

Copy objects	
object copy <Source project file> <Source path> <Target path>	Copy objects from the specified path of the source project file into the target path of the currently open project. If the source path is the name of an object, that object will be copied. If it is a folder, all objects under this folder will be copied. In this case, the folder structure under the source folder will be accepted. If the target path does not yet exist, it will be generated.

Set the communication parameters (gateway, device)	
gateway local	Set the gateway of the local processor as the current gateway
gateway tcpip <Address> <Port>	Set the gateway set in the specified remote processor as the current gateway <Address>: TCP/IP address or host name of the remote processor <Port>: TCP/IP port of the remote gateway Caution: Only those gateways without a set password can be accessed!
device guid <guid>	Set the device with the specified GUID as the current device. The GUID must correspond to the following format: {01234567-0123-0123-0123-0123456789ABC} The curly brackets and hyphens must be located at the specified positions.
device name <devicename>	Set the device with the specified name as the current device.

Set the communication parameters (gateway, device)	
device instance <Instance name>	Set the instance name for the current device to the specified name.
device parameter <Id>I<paramtername> <value>	Assign the parameter with the specified ID, or optionally the specified parameter name, the specified value that will then be interpreted by the device.

System call	
system <Command>	Execute the specified operating system command.

Select automation system	
target <Id>I<name>	Set the target platform for the current project. Specification of target ID or optionally the target name, as specified in the target file.

Command file command.cmd

```
file open C:\projects\DDS_test\ampel.pro
query off ok
watchlist load c:\work\w.wtc
online login
online run
delay 1000
watchlist read
watchlist save c:\work\watch.wtc
online logout
file close
```

This command file

- opens the project file ampel.pro
- loads a Watch list loaded under w.wtc
- starts the user program
- after one second writes the variable values into the Watch list watch.wtc that is saved
- and then closes the project again.

The command file is called as follows in the command line:

”<Path DDS file>” ”<Path cmd file>”

15.3 IEC keywords

Keywords are unique character combinations used as individual syntax elements.

- Keywords must not be used as identifiers.
- Keywords under the **Drive PLC Developer Studio** also include the names of Lenze function blocks, that always start with ”L_” (`L_ABS` , `L_ADD` , ...).

Keywords reserved for IEC 61131-3 programming languages:

ABS	ACOS	ACTION	ADD	AND	ANDN
ANY	ANY_BIT	ANY_DATE	ANY_INT	ANY_NUM	ANY_REAL
ARRAY	ASIN	AT	ATAN		
BOOL	BY	BYTE			
CAL	CALC	CALCN	CASE	CD	CDT
CLK	CONCAT	CONFIGURATION	CONSTANT	COS	CTD
CTU	CTUD	CU	CV		
DATE	DATE_AND_TIME	DELETE	DINT	DIV	DO
DS	DT	DWORD			
ELSE	ESIF	END_ACTION	END_CASE	END_CONFIGURATION	END_FOR
END_FUNCTION	END_FUNCTION_BLOCK		END_IF	END_PROGRAM	END_REPEAT
END_RESOURCE	END_STEP	END_STRUCT	END_TRANSITION	END_TYPE	END_VAR
END_WHILE	EN	ENO	EQ	ET	EXIT
EXP	EXPT				
FALSE	F_EDGE	F_TRIG	FIND	FOR	FROM
FUNCTION	FUNCTION_BLOCK				
GE	GT				
IF	IN	INITIAL_STEP	INSERT	INT	INTERVAL
JMP	JMPC	JMPCN			
L	LD	LDN	LE	LEFT	LEN
LIMIT	LINT	LN	LOG	LREAL	LT
LWORD					
MAX	MID	MIN	MOD	MOVE	MUL
MUX					
N	NE	NEG	NOT		
OF	ON	OR	ORN		
P	PRIORITY	PROGRAM	PT	PV	
Q	Q1	QU	QD		

R	R1	R_TRIG	READ_ONLY	READ_WRITE	REAL
RELEASE	REPEAT	REPLACE	RESOURCE	RET	RETAIN
RETC	RETCN	RETURN	RIGHT	ROL	ROR
RS	RTC	R_EDGE			
S	S1	SD	SEL	SEMA	SHL
SHR	SIN	SINGLE	SINT	SL	SQRT
SR	ST	STEP	STN	STRING	STRUCT
SUB					
TAN	TASK	THEN	TIME	TIME_OF_DAY	TO
TOD	TOF	TON	TP	TRANS	TRUE
TYPE					
UDINT	UINT	ULINT	UNTIL	USINT	
VAR	VAR_ACCESS	VAR_EXTERNAL	VAR_GLOBAL	VAR_INPUT	VAR_IN_OUT
VAR_OUTPUT					
WHILE	WITH	WORD			
XOR	XORN				

15.4 Key combinations and function keys

The available key combinations and function keys are listed as follows:

General operation

Function	Keyboard command
Toggle between declaration and instruction parts of an organization unit	**<F6>**
Toggle between *Object Organizer*, object and message window	**<Alt>+<F6>**
Shortcut menu	**<Umschalt>+<F10>**
Short form mode for declarations	**<Ctrl>+<Enter>**
Open and close multi-level variables	**<Enter key>**
Open and close folders	**<Enter key>**
Move among tab cards in the *Object Organizer* and Library Manager	**<Arrow keys>**
Jump in dialogs	**<Tab>**
Context-sensitive help	**<F1>**

General commands

Menu command	Keyboard command
File → Save	**<Ctrl>+<S>**
File → Print	**<Ctrl>+<P>**
File → Exit	**<Alt>+<F4>**
Project → Delete object	**<Del>**
Project → Insert object	**<Ins>**
Project → Rename object	**<Space bar>**
Project → Edit object	**<Enter key>**
Project → Check all	**<Ctrl>+<F11>**
Project → Compile all	**<F11>**
Edit → Undo	**<Ctrl>+<Z>**
Edit → Redo	**<Ctrl>+<Y>**
Edit → Cut	**<Ctrl>+<X>** or **<Umschalt>+<Del>**
Edit → Copy	**<Ctrl>+<C>**
Edit → Insert	**<Ctrl>+<V>**
Edit → Delete	**<Del>**
Edit → Find next	**<F3>**
Edit → Help Manager	**<F2>**
Edit → Next fault	**<F4>**
Edit → Previous fault	**<Umschalt>+<F4>**
Online → Log-in	**<Alt>+<F8>**
Online → Log-out	**<Ctrl>+<F8>**
Online → Start	**<F5>**
Online → Stop	**<Umschalt>+<F8>**
Online → Breakpoint on/off	**<F9>**
Online → Single step over	**<F10>**
Online → Single step in	**<F8>**
Online → Single cycle	**<Ctrl>+<F5>**
Online → Write values	**<Ctrl>+<F7>**
Window → Messages	**<Umschalt>+<Esc>**

FBD editor commands

Menu command	Keyboard command
Insert → Network (after)	<Ctrl>+<T>
Insert → Assignment	<Ctrl>+<A>
Insert → Jump	<Ctrl>+<L>
Insert → Return	<Ctrl>+<R>
Insert → Operator	<Ctrl>+<O>
Insert → Function	<Ctrl>+<F>
Insert → Function block	<Ctrl>+<B>
Insert → Input	<Ctrl>+<U>
Extras → Negation	<Ctrl>+<N>
Extras → Zoom	<Alt>+<Enter>

LD editor commands

Menu command	Keyboard command
Insert → Network (after)	<Ctrl>+<T>
Insert → Contact	<Ctrl>+<O>
Insert → Parallel contact	<Ctrl>+<R>
Insert → Function block	<Ctrl>+<B>
Insert → Coil	<Ctrl>+<L>
Extras → Paste below	<Ctrl>+<U>
Extras → Negation	<Ctrl>+<N>

SFC editor commands

Menu command	Keyboard command
Insert → Step transition (before)	<Ctrl>+<T>
Insert → Step transition (after)	<Ctrl>+<E>
Insert → Alternative branch (right)	<Ctrl>+<A>
Insert → Parallel branch (right)	<Ctrl>+<L>
Insert→ Jump	<Ctrl>+<U>
Extras → Zoom action/transition	<Alt>+<Enter>
Change from SFC overview back to editor	<Enter>

CFC editor commands

Menu command	Keyboard command
Insert → Box	<Ctrl>+<B>
Insert → Input	<Ctrl>+<E>
Insert → Output	<Ctrl>+<A>
Insert → Jump	<Ctrl>+<J>
Insert → Label	<Ctrl>+<L>
Insert → Return	<Ctrl>+<R>
Insert → Comment	<Ctrl>+<K>
Insert → Box input	<Ctrl>+<U>
Extras → Negation	<Ctrl>+<N>
Extras → Set/Reset	<Ctrl>+<T>
Extras → EN/ENO	<Ctrl>+<O>

Operation of PLC configuration

Function	Keyboard command
Open and close organization elements	**<Enter>**
Draw edit frame around the name	**<Space bar>**

Operation of task configuration

Function	Keyboard command
Draw edit frame around task or program name	**<Space bar>**

15.5 Error messages

The DDS will display the following error messages in alphabetical sequence in the message window after a log-in or compile.

Note!
Contact your Lenze representative for any error message not described in this chapter.

15.5.1 Warnings

No.	Cause	Possible remedy
1100	Unknown function <Name> in library.	You are using an external library. Check that all functions in the .hex file are also defined in the .lib file.
1101	Unresolved icon <Icon>.	The code generator expects an organization unit named <Icon> that has not been defined in the project. Define a function / program with the relevant name.
1102	Incorrect interface for icon <Icon>.	The code generator expects a function named <Icon> and with a scalar input or a program named <Icon> without input or output.
1103	The constant %s at code address <%04X %04X> is above a 16K page limit!	A string constant is above the 16K page limit.The system cannot handle this. Depending on the runtime system, there may be an option to avoid this from happening by making an input in the target file. Contact the control manufacturer.
1200	Task %s: Call of %s access variables in the parameter list not updated.	Variables that are used only for a function block call in the task configuration are not included in the cross reference list.
1300	File <Name> not found	The file referenced by the global variable object does not exist. Check the path.
1301	Analysis library not found. Analysis code not generated.	You are using the Analyze function although the library analyzation.lib is missing. Insert the library into the Library Manager.
1302	New externally referenced functions inserted. Online change is no longer possible!	Since the last download, you have integrated a library with functions that have not been referenced yet in the runtime system so that the whole project must be downloaded.
1400	Unknown compiler directive <Name> is ignored!	The compiler does not support this pragma. Refer index word **Pragma** for supported directives.
1401	The structure <Name> contains no elements.	The structure contains no elements, although variables of this type take up 1 Byte memory.
1500	This expression contains no assignment. No code generated.	The result of this expression is not used so that no code is generated for the complete expression.
1501	String constant transferred as VAR_IN_OUT: <Name> must not be overwritten!	The constant must not be written in the body of the organization unit as no size check is possible there.
1502	Variable <Name> bears the same name as an organization unit. The organization unit is not called!	You are using a variable that bears the same name as an organization unit. `PROGRAM a` `VAR_GLOBAL` `   a: INT;` `END_VAR` ... a; (* The process does not call organization unit a, but loads variable a.*)
1503	The organization unit has no outputs, connection continued with TRUE.	You are connecting the output pin of an organization unit without outputs further in FBD or LD. The connection is automatically assigned the value TRUE.
1504	Instruction not executed, possibly dependent on logical expression.	It is possible that not all branches of the logical expression are executed. IF a AND funct(TRUE) THEN... If a = FALSE, funct will no longer be called.
1505	Side effect in <Name>! Branch will possibly not be computed	The first input of the organization unit is FALSE, so that the side branch entering at the second input is possibly no longer computed.
1506	Variable %s bears the same name as a local action. The action is not called.	Rename the variable or the action to avoid identical names.
1600	Open DB unclear (generated code may be incorrect).	The original Siemens program does not reveal which data block is open.
1700	Input not connected.	You are using an input box in the CFC that is not connected further. No code will be generated for this.
1800	<Name>(Element #<Element number>): Incorrect Watch expression <Name>	The visualization element contains an expression that cannot be monitored. Check variable name and placeholder substitutes.
1801	No entry possible to expression.	You are using a composite expression as the target of an entry action in the visualization object configuration. Replace this with a single variable.
1900	The POU <Name> (entry function) is not available in the library.	The entry organization unit (e. g. PLC_PRG) will not be available during library use.

No.	Cause	Possible remedy
1901	Access variables and configuration variables are not saved in a library!	Access variables and variable configurations are not saved in the library.
1902	<Name>: Library not suitable for the current machine type!	The .obj file of the library was generated for a different machine type.
1903	<Name>: Incorrect library	The file does not correspond to the file format required by the automation system.
2900	A system organization unit was used in a scale function. It is possible that no process image will be generated for this system organization unit. Chapter on Scale functions (🕮 8-18).	Ensure with the help of the process image monitor that a process image is generated for the applied system organization unit. 🕮 8-20
2901	A system organization unit was used in a system POU. It is possible that no process image will be generated for this system organization unit. Chapter System POUs in the automation system documentation (🕮 2-7)	Ensure with the help of the process image monitor that a process image is generated for the applied system organization unit. **Caution!** Even if a process image is generated, some system POUs may cause problems if the data do not exist yet at the time of processing.
2902	Invalid target path for the GDC device description. An error occurred during generation of the GDC device description. For the error cause refer to the transmitted error code: 100: No valid name for the device description 200: Basic device description could not be opened 300: Error in basic device description	100: Use **Project→Options** category *Device description* to specify a different path. 200, 300: Deinstall the DDS and correctly reinstall it. If the error still occurs, please contact your Lenze representative.
2903	A user code is using an unknown unit.	Define the applied unit in the Instance Parameter Manager. 🕮 8-11
2904	The code reference to an organization unit could not be resolved.	The organization unit was deleted.
2905	The binary file project name.bin (*.bin) could not be created.	The *.bin file may be write-protected. Remove the write protection.

15.5.2 Compile errors

No.	Cause	Possible remedy
3100	Program too large. Maximum size: <Number> byte (<Number>K)	Maximum program size exceeded. Reduce program size.
3101	Data area too large. Maximum size: <Number> byte (<Number>K)	The data memory is full. Reduce your applications data requirement.
3110	Error in library file <Name>.	The .hex file does not correspond to the INTEL hex format.
3111	Library <Name> is too big. Maximum size: 64K	The .hex file exceeds the maximum possible size.
3112	Irrelocatable instruction in library.	The .hex file contains an irrelocatable instruction. The library code can not be linked.
3113	Library code overwriting function tables.	The code and information table sections overlap.
3114	Library uses more than one segment.	The tables and code in the .hex file use more than one segment.
3115	Constant cannot be assigned to VAR_IN_OUT. Incompatible data types.	The internal pointer format for string constants cannot be converted into the internal pointer format of VAR_IN_OUT as the data are defined as near and the string constants as huge or far. Change these automation system settings if possible
3120	Current code segment in excess of 64K.	The system code just generated is in excess of 64K. The system possibly requires too much initialization code.
3121	Organization unit too big.	An organization unit must not exceed 64K.
3122	Initialization too large. Maximum size: 64K	The initialization code for a function block or a structure must not exceed 64K.
3130	Application stack too small: <Number> DWORD required <Number> DWORD available.	The organization unit calls are nested too deeply. Enlarge the stack size in the automation system settings, or compile the program without the project compile option Debug.
3131	User stack too small: <Number> WORD required, <Number> WORD available.	Contact the control manufacturer.
3132	System stack too small: <Number> WORD required, <Number> WORD available.	Contact the control manufacturer.
3150	Parameter %d of function <Name>: The result of an IEC function cannot be transferred to a C function as string parameter.	Use an intermediate variable. Transfer the result of an IEC function to the variable.
3160	Cannot open library file <Name>.	The file <Name> required for a library cannot be found.
3161	Library <Name> contains no code segment	An .obj file of a library must contain at least one C function. Insert a dummy function into the .obj file, that is not defined in the .lib file.
3162	Cannot resolve reference in library <Name> (Icon <Name>, Class <Name>, Type <Name>)	The .obj file contains an irresolvable reference to another icon. Check the C compiler settings.

No.	Cause	Possible remedy
3163	Unknown reference type in library <Name> (Icon <Name>, Class <Name>, Type <Name>)	The .obj file contains a reference type the code generator cannot resolve. Check the C compiler settings.
3200	<Name> (%d): Logical expression too complex.	The temporary memory of the automation system is insufficient to cope with the size of the expression. Divide the expression into several part expressions with assignments to intermediate variables.
3201	<Name> (<Network>): A network may return a maximum of 512 byte code.	Internal jumps cannot be resolved. Activate the option Use 16 bit jump offsets in the 68k target settings.
3202	Stack overflow on nested string/array/structure function calls.	You are using a nested form CONCAT(x, f(i)) function call. This may lead to data loss. Split the call into two expressions.
3203	Assignment too complex (too many address registers required)	Split the assignment.
3204	A jump is in excess of 32k bytes.	Jump distances must not exceed 32767 bytes.
3205	Internal error: Too many constant strings	A maximum of 3000 string constants may be used within one organization unit.
3206	Function block too large	A function block may return a maximum of 32767 bytes code.
3207	Array optimization Unsuccessful array access optimization.	A function was called within the index computation.
3208	Conversion not implemented	You are using a conversion function that is not implemented for the current code generator.
3209	Operator not implemented	You are using an operator that is not implemented for this data type in the current code generator: MIN(string1,string2).
3210	Function <Name> not found	You are calling a function that does not exist within the project.
3211	String variable used too often	A string-type variable must only be used ten times in an expression with the 68K code generator.
3250	Real not supported on 8 bit controller.	The automation system is currently not supported.
3251	Date-of-day types not supported on 8 bit controller.	The automation system is currently not supported.
3252	Stack size in excess of %ld bytes.	The automation system is currently not supported.
3253	Hex file not found: <Name>	The automation system is currently not supported.
3254	Call of an external library function could not be resolved.	The automation system is currently not supported.
3400	Error on access variable import.	The .exp file contains an incorrect access variable section.
3401	Error on Configuration variable import.	The .exp file contains an incorrect configuration variable section.
3402	Error on global variable import.	The .exp file contains an incorrect global variable section.
3403	<Name> could not be imported.	The section in the .exp file for the specified object is incorrect.
3404	Error on Configuration Task import.	The section in the .exp file for the Configuration Task is incorrect.
3405	Error on PLC configuration import.	The section in the .exp file for the PLC configuration is incorrect.
3406	Two steps named <Name>. The second step was not imported.	The SFC organization unit section contained in the .exp file includes two steps with identical names. Rename one of the steps in the export file.
3407	Input step <Name> not found	The named step is missing in the .exp file.
3408	Subsequent step <Name> not found	The named step is missing in the .exp file.
3409	No subsequent transition for step <Name>	A transition requiring the named step as the entry step, is missing in the .exp file.
3410	No subsequent step for transition <Name>	A step requiring the named transition is missing in the .exp file.
3411	Step <Name> cannot be accessed from Init Step	The link between the named step and the Init Step is missing in the .exp file.
3450	PDO<Name>: <Module name> <Configuration dialog name> <PDO Name> COB-Id missing!	Click the button Properties in the configuration dialog <Configuration dialog name> of module <Module name> and enter a COB ID for PDO <PDO Name>.
3451	Loading error: EDS file <Name> could not be found, but is used in the configuration!	The device file required for CAN configuration may possibly not be available in the correct directory. Check the directory entry for configuration files in **Project→Options** category *Directories*.
3452	The module <Name> could not be generated!	The device file for module <Name> no longer suits the current configuration. It may have been changed since the original configuration, or be corrupted.
3453	Channel <Name> could not be generated!	The device file for channel <Name> no longer suits the current configuration. It may have been changed since the original configuration, or be corrupted.
3454	The address <Name> references an assigned memory location!	You have activated the option **Check for overlapping addresses** in dialog *Settings* of the PLC configuration, and an overlap was found. Note that the range check is based on the size resulting from the module data type, and not the value in the entry Size in the configuration file!
3455	Loading error: GSD file <Name> could not be found, but is used in the configuration!	The device file required for Profibus configuration may possibly not be available in the correct directory. Refer entry for configuration files in **Project→Options** category *Directories*.
3456	The Profibus device <Name> could not be generated!	The device file for device <Name> no longer suits the current configuration. It may have been changed since the original configuration, or be corrupted.
3457	Incorrect module description: <Name>!	Check the device file pertaining to the module.
3500	No VAR_CONFIG for <Name>	Insert a declaration for the named variable in the global variable list with **Variable_Configuration**. **Resources→Global_Variables** 🕮 8-2

No.	Cause	Possible remedy
3501	No address in VAR_CONFIG for <Name>	Insert an address for the named variable in the global variable list with **Variable_Configuration**. **Ressourcen→Global_Variables** 📖 8-2
3502	Wrong data type of <Name> in VAR_CONFIG	The named variable was declared in the global variable list (with Variable configuration) with a different data type than in the function block.
3503	Wrong address type of <Name> in VAR_CONFIG	The named variable was declared in the global variable list (with Variable configuration) with a different address type than in the function block.
3504	Initial values for VAR_CONFIG variables are not supported	A Variable Configuration variable has been declared with address and initial value. However, an initial value can be defined only for input variables without address assignment.
3505	<Name> is no valid instance path	A non-existent variable was specified in the variable configuration.
3506	Access path expected	A correct access path is missing for one variable in the global variable list for access variables: <Identifier>:'<Access path>':<Type> <Access type>
3507	No address specification permitted for VAR_ACCESS	An address assignment exists for one variable in the global variable list for access variables. Correct definition: <Identifier>:'<Access path>':<Type> <Access type>
3550	The task name <Name> was used twice	You have defined two tasks with the same name. Rename one of them.
3551	The task <Name> must contain at least one program call	Insert a program call, or delete the task.
3552	Event variable <Name> in task <Name> not defined	You have used an event variable in the configuration of the named task, that is not globally declared in the project. Use a different variable or define the entered variable globally.
3553	Event variable <Name> in task <Name> must be BOOL-type	Use a BOOL-type variable as event variable.
3554	Task entry <Name> must be a program or a global function block instance.	You have entered a function or an undefined organization block in the field Program call.
3555	The task entry <Name> is parameterized incorrectly	You have specified parameters in the field Program call that do not correspond to the declaration of the organization block.
3600	Implicit variable not found.	First use the command **Compile all**. Contact the control manufacturer if the error message reappears.
3601	<Name> is a reserved variable name.	You have declared a variable in the project that is already reserved for the code generator. Rename this variable.
3610	<Name> not supported	The named feature is not supported by this version.
3611	The compile directory <Name> is incorrect.	You have entered an incorrect directory for the compile files in the **Project→Options** Category *Directories*.
3612	Maximum number of organization units (<Number>) exceeded! Compile will be aborted.	You are using too many organization units and data types in the project. Change the maximum number of organization units in dialog box *Automation system settings* tab *Memory layout*. Note! The tab memory layout cannot be edited at the moment.
3613	Compile terminated	The user terminated the compile.
3614	The project contains no organization unit <Name> (entry function) or task configuration	A project requires a Program-type entry function (e.g. PLC_PRG) or a task configuration.
3615	<Name> (entry function) must be Program-type.	You are using an entry function (e. g. PLC_PRG) other than Program-type.
3616	Programs in external libraries are not supported	The library to be saved contains a program that will not be available during library use.
3617	Insufficient memory	Increase the virtual memory capacity of your processor.
3618	The current code generator does not support bit access	The code generator for the currently set automation system does not support bit access to variables.
3700	An organization unit named <Name> already exists in library <Name>	You are using an organization unit name that has already been assigned for a library organization unit. Rename the organization unit.
3701	The organization unit name in the declaration name does not match the name in the object list.	Rename your organization unit using the menu commands **Project→Rename object** or change the name of the organization unit in its declaration part. The name must appear directly after the keywords Program, Function or Function block.
3702	Too many identifiers	A maximum of 100 identifiers may be specified per variable declaration.
3703	Several declarations with the same identifier <name>	Several identically named identifiers exist in the object's declaration part.
3705	Data recursion: <Organization unit 0> → <Organization unit 1> → ... → <Organization unit 0>	An FB instance was used that requires itself to function.
3720	AT must be followed by an address.	Insert a valid address after the keyword AT or change the keyword AT.
3721	Only VAR and VAR_GLOBAL can be assigned to addresses.	Copy the declaration to a VAR or VAR_GLOBAL section.
3722	Only simple Boolean variables may be located at the specified address.	Change the address or the variable type stated in the declaration.
3722	Only simple Boolean variables may be located at the specified address.	Change the address or the variable type stated in the declaration.
3728	PLC_PRG(): Impermissible address %IX141.58.0.	Specify a correct address.

No.	Cause	Possible remedy
3740	Unknown type: <Name>	You are using an incorrect type for variable declaration.
3741	Type identifier expected	You are using a keyword or an operator instead of a correct type identifier.
3742	Enumeration value expected	An identifier is missing behind the left parenthesis, or behind a comma within the area in parentheses, in the definition of the enumeration type.
3743	Integer expected	Enumeration values can only be initialized with INT-type integers.
3744	Enumeration constant <Name> already defined	Check that you have observed the following rules while assigning enumeration values. • All values must be unique within one enumeration definition. • All values must be unique within all global enumeration definitions. • All values must be unique within all local enumeration definitions of an organization unit.
3745	Range delimiters are permitted for integer data types only!	Subrange types may be defined based on integer data types only.
3746	Range delimiter <Name> incompatible with data type <Name>	A limit for the range specified for the subrange type is outside the limits permitted for the basic type.
3747	Unknown string length: <Name>	You are using an unknown constant to define the string length.
3748	More than 3 dimensions are impermissible for one array	You are using in excess of the permissible 3 dimensions for an array. Use an ARRAY OF ARRAY as required.
3749	Lower range limit <Name> unknown	You are using an undefined constant as the lower range limit of a subrange or array type.
3750	Upper range limit <Name> unknown	You are using an undefined constant as the upper range limit of a subrange or array type.
3760	Incorrect initial value bzw. Initialisierung von Pointern pt:POINTER TO<typ>:= ADR(variable); nicht möglich	Use an initial value that corresponds to the type definition. Use the variable declaration dialog for assistance. **Shift+F2** or **Edit→Variable configuration** Grundsätzlich sollten Pointer vermieden werden. Beachten Sie auch im Kapitel Datentypen den Abschnitt Pointer. 📖 10-4
3761	VAR_IN_OUT variables must have no initial value.	Remove the initialization in the variable declaration.
3780	VAR, VAR_INPUT, VAR_OUTPUT or VAR_IN_OUT expected	The first line after an organization unit name must contain one of these keywords.
3781	END_VAR or identifier expected	Insert a valid identifier or END_VAR at the beginning of the declaration line.
3782	Unexpected end	**Declaration part:** Insert the key word END_VAR at the end of the declaration part. **Text editor:** Insert instructions that end the last instruction sequence (END_IF, for example).
3783	END_STRUCT or identifier expected	Ensure that the type declaration is completed properly
3800	The global variables require too much memory. Increase the available memory in the project options	Increase the number of segments set in the build options in the project options.
3801	Variable <Name> is too big. (<Size> byte)	The variable is using a type larger than 1 data segment. Dependent on the automation system, the segment size can be defined in dialog box *Automation system settings* tab *Memory layout*. Contact the control manufacturer if you find no entry option there.
3802	Memory for Retain variables used up. Variable <Name>, %u byte.	The available memory area for Retain variables is exhausted. Dependent on the automation system, the memory area can be defined in dialog box *Automation system settings* tab *Memory layout*. Contact the control manufacturer if you find no entry option there. Note! Also that in the case of instances of function blocks in which a Retain variable is used, the Retain memory manages the complete instance.
3803	Memory area for global variables exhausted. Variable <Name>, <Number> byte.	The memory area available for global variables is exhausted. • The available memory area depends on the target system. • Information about the memory area available for the target system is given in the dialog box *Target settings*, tab **Memory layout**.
3820	VAR_OUTPUT and VAR_IN_OUT not allowed in functions.	You must not define any output / reference parameters in a function.
3821	At least one input required for a function	Insert at least one input parameter for the function.
3840	Unknown global variable <Name>.	You are using a VAR_EXTERNAL variable in the organization unit, for which no associated global variable has been declared.
3841	Declaration of <Name> does not match global declaration!	The type specified in the declaration of the VAR_EXTERNAL variable does not match that in the global declaration.
3900	Multiple underscores in the identifier.	Remove multiple underscores in the identifier name.
3901	Max. 4 address fields allowed.	You are using a direct address assignment to an address that contains in excess of four levels (e. g %QB0.1.1.0.1).
3902	Keywords must be written in uppercase	Write the keyword in uppercase or activate the option Autoformat.
3903	Incorrect time constant	The constant is not specified in accordance with the IEC 61131-3 format.
3904	Time constant overflow	You are using a value for the time constant that can no longer be represented within the internal format. The maximum representable value is t#49d17h2m47s295ms.
3905	Incorrect date constant	The constant is not specified in accordance with the IEC 61131-3 format.
3906	Incorrect time-of-day constant	The constant is not specified in accordance with the IEC 61131-3 format.
3907	Incorrect date/time constant	The constant is not specified in accordance with the IEC 61131-3 format.
3908	Incorrect string constant	The string constant includes an incorrect character.
4000	Identifier expected	Enter a correct identifier here.

No.	Cause	Possible remedy
4001	Variable <Name> not declared	Declare the variable locally or globally.
4010	Incompatible types: Cannot convert <Name> into <Name>.	Check the required operator types and change the type of the variable that caused the error into a permissible type, or select a different variable.
4011	Impermissible type in parameter <Parameter> of <Name>: Cannot convert <Name> into <Name>.	The actual parameter type cannot be converted into the formal parameter type. Use a type conversion or a suitable variable type.
4012	Impermissible type for input <Name> of <Name>: Cannot convert <Name> into <Name>.	The variable <Name> is assigned a value of an impermissible type <Type2>. Change the variable or the constant into a variable or constant of type <Type1> or use a type conversion or a constant with a type prefix.
4013	Impermissible type for output <Name> of <Name>: Cannot convert <Name> into <Name>.	The variable <Name> is assigned to a value of an impermissible type <Type2>. Change the variable or the constant into a variable or constant with type <Type1> or use a type conversion or a constant with a type prefix.
4014	Constant with type prefix: <Name> cannot be converted to <Name>.	The constant type is incompatible with the prefix type. Example: SINT#255
4015	Impermissible data type <Name> for direct bit access	Direct bit addressing is permitted for integer and bitstring data types only. You are using a type REAL/LREAL variable var1 in bit access <var1>.<bit> or a constant.
4016	Bit index <%d> outside the valid range for <Name>-type variables	You are attempting access to a bit that is not defined for the variable's data type.
4017	MOD is not defined for REAL	The operator MOD can be used for integer and bitstring data types only.
4020	ST, STN, S, R operands must be write-access variables	Replace the first operand with a variable with write access.
4021	No write access to <Name>	Replace the variable with one with write access.
4022	Operand expected	Add an operand behind the existing command.
4023	Number expected after "+" or "-".	Enter a number.
4024	Expect <Operator 0> or <Operator 1> or ... in front of <Name>	Enter a correct operator at the named position.
4025	Expect := or => in front of <Name>	Enter one of the two operators at the named position.
4026	BITADR expects a bit address or a variable at a bit address	Use a correct bit address (for example %IX0.1).
4027	Integer or symbolic constant expected	Insert an integer or the identifier of a correct constant.
4028	INI operator requires a function block instance or a structure variable	Check the type of the variable to which you apply the INI operator.
4029	Internested calls of the same function are not possible.	In non-reentrant automation systems and in simulation mode, a function call must not contain a call for itself as parameter. Example: fun1(a,fun1(b,c,d),e);Use an intermediate variable.
4030	No constants and expressions are allowed as ADR operands	Replace the constant or the expression with a variable or a direct address.
4031	The address operator is not permitted on bits !	Use BITADR. BITADR returns no physical memory address.
4032	<Number> operands insufficient for <Name>. At least <number> are required.	Check how many operands are required by the operator <Name> and insert the missing operands.
4033	<Number> operands too high for <Name>. Exactly <number> are required.	Check how many operands are required by the operator <Name> and remove the superfluous operands.
4034	Division by 0	You are using a division by 0 in a constant expression. If necessary, use a value-0 variable to force a runtime error.
4035	ADR must not be applied on VAR CONSTANT if Replace constants is active.	No address access is possible to constants for which the direct values are used. If required, deactivate the option Substitute constants in the project options, category Compilation options.
4040	Jump label <LabelName> is not defined	Define a label named <LabelName> or change <LabelName> into a defined label.
4041	Jump label <Name> defined more than once	The label <Name> is defined more than once within the organization unit. Rename it, or remove one definition.
4042	The number of successive jump labels must be max. <Number>	The number of jump labels per instruction is limited to <Number>. Insert a dummy instruction.
4043	Incorrect label format: A label must be an identifier that may be followed by a colon.	The name used for the label is either no valid identifier, or the colon is missing in the definition.
4050	Organization unit <Name> does not exist in the project	Define an organization unit named <Name> using the menu commands **Project→Insert object**, or change <Name> to the name of a defined organization unit.
4051	<Name> is not a function.	Use a function name defined in the project or in the libraries for <Name>.
4052	<Instance name> must be a declared instance of function block <Name>	Use a type <Name> instance defined in the project for <Instance name>, or change the type from <Instance name> to <Name>.
4053	<Name> is no valid organization unit or operator	Replace <Name> with the name of an organization unit or an operator defined in the project.
4054	Organization unit name expected as parameter of INDEXOF	The specified parameter is no valid organization unit name
4060	VAR_IN_OUT parameter <Name> of <Name> requires write-accessible variable as input.	Write-accessible variables must be transferred to VAR_IN_OUT parameters as these can be modified within the organization unit.

No.	Cause	Possible remedy
4061	VAR_IN_OUT parameter <Name> of <Name> must be assigned.	Write-accessible variables must be assigned to VAR_IN_OUT parameters as these can be modified within the organization unit.
4062	No external access to VAR_IN_OUT parameter <Name> of <Name>.	VAR_IN_OUT parameters must only be written or read within the organization unit (reference transfer).
4063	VAR_IN_OUT parameter <Name> of <Name> cannot be assigned bit addresses.	A bit address is no valid physical address. Transfer a variable or a direct non-bit address.
4064	VAR_IN_OUT must not be overwritten in local action call !	Delete the assignment of the VAR_IN_OUT variables for the local action call.
4070	Too deeply nested expression in organization unit.	Reduce the nesting depth by distributing the expression across several expressions with the help of assignments to intermediate variables.
4071	Network too large	Divide the network into several networks.
4100	^ requires a pointer type	You are attempting to dereference a variable that has not been declared as POINTER TO.
4110	[<index>] only allowed for array variables	You are using [<index>] for a variable that has not been declared as ARRAY OF.
4111	The expression in the index of an array must have an INT-type result.	Use an expression of the respective type, or a type conversion.
4112	Too many array indices	Check the number of indices (1, 2, or 3) for which the array has been declared, and remove the superfluous indices.
4113	Insufficient array indices	Check the number of indices (1, 2, or 3) for which the array has been declared, and add the missing indices.
4114	Constant index outside array boundaries	Ensure that the applied indices range within the array boundaries.
4120	A "**.**" must be preceded by a structure variable.	The identifier to the left of the period must be a STRUCT or FUNCTION_BLOCK-type variable or the name of a FUNCTION or a PROGRAM.
4121	<Name> is no component of <Object name>.	The component <Name> is not included in the definition of object <Object name>.
4122	<Name> is not an input parameter of the called function block.	Check the input variables of the called function block, and change <Name> into one of these variables.
4200	LD expected	Add at least one LD instruction in the editor window of the IL organization unit or behind the jump label.
4201	IL operator expected	Every IL instruction must start with an operator or a jump label.
4202	Unexpected end of the subexpression	Insert the right parenthesis.
4203	<Name> in parentheses not allowed	The specified operator is not permitted within an IL subexpression. (impermissible are: JMP, RET, CAL, LDN, LD, TIME)
4204	Right parenthesis without left parenthesis.	Insert left parenthesis, or delete right parenthesis.
4205	No comma permitted after)	Remove the comma behind the right parenthesis.
4206	No jump labels in subexpressions.	Move the jump label outside the subexpression.
4207	N modifier requires a BOOL, BYTE, WORD or DWORD-type operand.	The N modifier requires a data type for which a Boolean negation can be performed.
4208	The expression in front of a conditional command must return a BOOL-type result	Ensure that the expression returns a Boolean result, or use a type conversion.
4209	Function names are not allowed here.	Replace the function call with a variable or constant.
4210	CAL, CALC and CALN require a function block instance as an operand	Declare an instance of the function block to be called.
4211	Comments in IL at the end of the line only.	Move the comment to the end of the line or into a separate line.
4212	Accumulator invalid before conditional instruction	The accumulator content is not defined. This is the case after instructions that do not return any result (CAL, for example).
4213	S and R require a BOOL-type operand	Use a Boolean variable at this position.
4250	No correct start for an ST instruction	The line does not start with a correct ST instruction.
4251	Function <name> has too many parameters.	More parameters were specified than were declared in the function definition.
4252	Function <name> has insufficient parameters.	Fewer parameters were specified than were declared in the function definition.
4253	IF and ELSIF require a Boolean expression as condition	Ensure that the condition following an IF and ELSIF is a Boolean expression.
4254	WHILE requires a Boolean expression as condition	Ensure that the condition following a WHILE is a Boolean expression.
4255	UNTIL requires a Boolean expression as condition	Ensure that the condition following an UNTIL is a Boolean expression.
4256	NOT requires a Boolean operand.	Ensure that the condition following a NOT is a Boolean expression.
4257	The counter of the FOR instruction must be INT-type	Ensure that the counter variable is an integer or bitstring data type (DINT, DWORD, for example).
4258	The counter in the FOR instruction is no write-accessible variable	Replace the counter variable with a write-accessible variable.
4259	The start value of the FOR instruction must be INT-type.	The start value of the FOR instruction must be compatible with the counter variable type.
4260	The end value of the FOR instruction must be INT-type.	The end value of the FOR instruction must be compatible with the counter variable type.
4261	The incrementation value of the FOR instruction must be INT-type.	The incrementation value of the FOR instruction must be compatible with the counter variable type.
4262	EXIT is permitted only within a loop.	Use EXIT only within FOR, WHILE or UNTIL instructions.
4263	Number, ELSE or END_CASE expected	Only a number or an ELSE instruction, or the end instruction END_CASE, can be specified within a CASE.

No.	Cause	Possible remedy
4264	The selector of the CASE instruction must be INT-type.	Ensure that the selector is an integer or bitstring data type (DINT, DWORD, for example).
4265	Number expected after,	In the CASE selector list, another selector must be specified after a comma.
4266	At least 1 instruction required.	Enter an instruction, at least a semicolon.
4267	A function block call must start with an instance name.	The identifier in the function block call is no instance. Declare an instance of the required function block, or use the name of an instance that has already been declared.
4268	Expression expected	Enter an expression at this position.
4269	END_CASE expected after ELSE branch	Complete the CASE instruction with an END_CASE after the ELSE branch.
4270	CASE constant %ld already in use	A CASE selector must be used once only within a CASE instruction.
4271	The lower limit of the specified range is greater than the upper limit.	Correct the selector range limits so that the lower limit is not greater than the upper limit.
4272	Parameter <Name> expected at <Position> in <Name> call!	If the function parameters within the function call are specified with parameter names, the position of the parameters (sequence) must match that in the function definition.
4273	CASE range <range limits> overlaps with already used range <range limits>	Ensure that the selector ranges specified in the CASE instruction do not overlap.
4274	Multiple ELSE branch in CASE instruction	A CASE instruction must not contain in excess of one ELSE branch.
4300	Jump or Return require a Boolean input	Ensure that the input for the jump or the Return instruction is a Boolean expression.
4301	Organization unit <Name> requires exactly <number> inputs	The number of inputs does not match the number of VAR_INPUT and VAR_IN_OUT variables specified in the organization unit definition.
4302	Organization unit <name> requires exactly <number> outputs	The number of outputs does not match the number of VAR_OUTPUT variables specified in the organization unit definition.
4303	<Name> is not an operator	Replace <name> with a valid operator.
4320	Non-Boolean expression <name> used for contact	The switching signal for a contact must be a Boolean expression.
4321	Non-Boolean expression <name> used for coil	The output variable of a coil must be BOOL-type.
4330	Expression expected at input EN of organization unit <name>	Assign the input EN of organization unit <name> with an input or an expression.
4331	Expression expected at input <number> %d of organization unit <name>	The input of the operator organization unit is not assigned.
4332	Expression expected at input <name> of organization unit <name>	The input of the organization unit is VAR_IN_OUT-type and not assigned.
4333	Identifier expected in jump	The specified jump target is no valid identifier.
4334	Expression expected at jump input	Assign the jump input with a Boolean expression. If that is TRUE, the jump is executed.
4335	Expression expected at Return input	Assign the input of the Return instruction with a Boolean expression. If that is TRUE, the return is executed.
4336	Expression expected at output input	Link the output with the expression that can be assigned to this output.
4337	Identifier expected for input	Insert a valid expression or identifier in the input box.
4338	Organization unit <name> has no real inputs	None of the inputs of operator organization unit <name> is assigned with a valid expression.
4339	Incompatible types at output: Cannot convert <name> into <name>.	The expression in the output box is not type-compatible with the expression it is to be assigned.
4340	Jump requires a Boolean input	Ensure that the input for the jump is a Boolean expression.
4341	Return requires a Boolean input	Ensure that the input for the Return instruction is a Boolean expression.
4342	Input EN of the box requires a Boolean input	Link the EN input of the organization unit with a valid Boolean expression.
4343	Constant assignment: Impermissible type for parameter <name> of <name>: Cannot convert <type> into <type>.	You declared input <name> of organization unit <name> as VAR_INPUT CONSTANT, while assigning it an expression in the dialog Parameters that is not type-compatible.
4344	S and R require Boolean operands	Insert a valid Boolean expression behind the Set or Reset instruction.
4345	Impermissible type for parameter <name> of <name>: Cannot convert <type> into <type>.	You assigned an expression to input <name> of organization unit <name>, that is not type-compatible.
4346	An output must not be a constant	The target of an assignment must be a variable or direct address with write access.
4347	VAR_IN_OUT parameter requires write-accessible variable	Write-accessible variables must be transferred to VAR_IN_OUT parameters as these can be modified within the organization unit.
4350	An SFC action cannot be called from outside	SFC actions can be called only within the SFC organization unit within which they have been defined.
4351	Step name is no permissible identifier: <name>.	Rename the step, and select a valid identifier for the name.
4352	Permissible step name : <name> followed by invalid characters	Delete the impermissible characters in the step name.
4353	Step names used twice: <name>	Rename one of the steps.
4354	Jump to undefined step: <name>	Select an existing step name as the jump target, or insert a step with the as-yet undefined name.
4355	A transition must not have any side effects (assignments, FB calls etc.)	A transition must only contain a Boolean expression.
4356	Jump without valid step names: <name>	Use a valid identifier as jump target.
4357	IEC library not found	Check whether the library iecsfc.lib was integrated into the Library Manager, and whether the library paths specified in the project options are correct.

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Appendix

No.	Cause	Possible remedy
4358	Undeclared action: <name>	Ensure that the IEC step action is inserted in the Object Organizer below the SFC organization unit, and that the action name is entered in the box to the right of the qualifier.
4359	Invalid qualifier: <name>	Enter a qualifier for the IEC action in the box to the left of the action name.
4360	Time constant expected behind qualifier: <name>	Enter a time constant behind the qualifier for the IEC action in the box to the left of the action name.
4361	Identifier <name> identifies no action	Enter the name of an action or a Boolean variable defined in the project for the IEC action in the box to the right of the qualifier.
4362	Non-Boolean expression in action: <name>	Enter a Boolean variable or a valid action name.
4363	IEC step name already in use for variable: <name>	Rename the step or the variable.
4364	A transition must be a Boolean expression	The result of the transition expression must be BOOL-type.
4365	Step <name> has an incorrect time limit value	Open the dialog Step attributes for step <name> and enter valid time variables or constants.
4366	The label for the parallel step is no permissible identifier: <name>	Enter a valid identifier next to the triangle identifying the jump label.
4367	The label <name> already exists	You have already assigned this name to a jump label or a step. Rename accordingly.
4368	Action <name> used on several superimposed SFC levels !	You are using the action <name> both in the organization unit as well as in one or several actions of this organization unit.
4369	Exactly one network required for transitions	You have used several FBD or LD networks for the transition. Reduce to exactly one network.
4370	Superfluous lines behind correct IL transition	Delete the superfluous lines at the transition end.
4371	Superfluous characters after valid expression: <name>	Delete the superfluous characters at the transition end.
4400	Organization unit <name> imported or converted incomplete / with errors.	The organization cannot be converted completely to IEC 61131-3.
4401	S5 time constant <number> seconds too high (max. 9990s).	No valid BCD-coded time in accumulator.
4402	Direct access permitted to I/Os only.	Ensure that you are only accessing a variable defined as input or output.
4403	STEP5/7 command invalid or inconvertible to IEC 61131-3	Not every STEP 5/7 command can be converted to IEC 61131-3 (such as CPU commands like MAS, for example).
4404	STEP5/7 operand invalid or inconvertible to IEC 61131-3	Not every STEP5/7 operand can be converted to IEC 61131-3, or one operand missing.
4405	Reset of a STEP5/7 timer cannot be converted to IEC 61131-3.	The associated IEC timers have no Reset input.
4406	STEP5/7 counter constant too high (max. 999).	No valid BCD-coded counter constant in accumulator.
4407	STEP5/7 instruction cannot be converted to IEC 61131-3	Not every STEP5/7 instruction can be converted to IEC 61131-3 (such as DUF, for example).
4408	Bit access to timer / counter words cannot be converted to IEC 61131-3.	Specific timer / counter commands cannot be converted to IEC 61131-3.
4409	Accu1 or Accu2 contents undefined, cannot be converted to IEC 61131-3.	A command linking the two accumulators cannot be converted as the accumulator contents are not known.
4410	Called organization unit not in project	Import the called organization unit.
4411	Error in global variable list.	Check the SEQ file.
4412	Internal error no.11	Contact the control manufacturer.
4413	Incorrect format of a line within data organization unit	Code to be imported contains an incorrect date.
4414	FB/FX name missing	The symbolic name of an (extended) function block is missing from the original S5D file.
4415	Command not allowed after organization unit end	A protected organization unit cannot be imported.
4416	Invalid command	The S5/S7 command cannot be disassembled.
4417	Incomplete comment	Complete the comment with *).
4418	FB/FX name too long (max. 8 characters)	The symbolic name of an (extended) function block is too long.
4419	Expected line format (* Name: <FB/FX-Name> *)	Correct the line accordingly.
4420	FB/FX parameter name missing	Check the function blocks.
4421	FB/FX parameter type name invalid	Check the function blocks.
4422	FB/FX parameter type not specified	Check the function blocks.
4423	Invalid actual operand	Check the function block interface.
4424	Warning: Called organization unit does not exist, or header incorrect or has no parameters	The called function block has either not been imported yet, is faulty or has no parameters (ignore the message in the latter case).
4425	No jump label defined	The target of a jump has not been specified.
4426	Organization unit has no valid STEP5 name such as PB10, for example.	Change the organization unit name.
4427	No timer type specified	Insert a timer declaration into the global variable list.
4428	Maximum STEP5/7 parenthesis nesting depth exceeded	No more than seven left parentheses may be used.
4429	Error in formal parameter name	The parameter name must not be longer than four characters.
4430	Formal parameter type cannot be converted to IEC	Timers, counters and organization units cannot be converted as formal parameters to IEC 61131-3.
4431	Too many VAR_OUTPUT parameters for a call in STEP5/7 IL	An organization unit must not contain in excess of sixteen formal parameters as outputs

No.	Cause	Possible remedy
4432	Jump labels in the middle of an expression are not allowed	IEC 61131-3 specifies exact jump label positions.
4434	Too many labels	An organization unit must not contain in excess of 100 labels.
4435	No further connection after jump / call	A jump or call must be followed by a load command.
4436	VKE contents undefined, cannot be converted to IEC 61131-3.	A command using VKE cannot be converted as the VKE value is not known.
4437	The types of command and operand do not match	A bit command was applied to a Word operand, or viceversa.
4438	No data organization unit open (insert an A DB)	Insert an A DB.
4500	Unknown variable or address	This Watch variable is not declared in the project. Use the Help Manager **<F2>** for declared variables.
4501	A valid Watch expression is followed by invalid characters.	Remove the invalid characters.
4520	Error in compiler directive: Flag expected before <name>!	Pragma entered incorrectly. Check whether <name> is a valid flag.
4521	Error in compiler directive: Unexpected element <name>!	Check the pragma for correct composition.
4522	Flag off directive expected !	There is no flag off instruction.Add a flag off instruction.
4550	Index outside permitted range: Variable OD <number>, line <line number>.	Ensure that the index is within the range defined in dialog box *Automation system settings* tab *Network functions*.
4551	Subindex outside permitted range: Variable OD <number>, line <line number>.	Ensure that the subindex is within the range defined in dialog box *Automation system settings* tab *Network functions*.
4552	Index outside permitted range: Parameter OD <number>, line <line number>.	Ensure that the index is within the range defined in dialog box *Automation system settings* tab *Network functions*.
4553	Subindex outside permitted range: Parameter OD <number>, line <line number>.	Ensure that the subindex is within the range defined in dialog box *Automation system settings* tab *Network functions*.
4554	Invalid variable name: Variable OD <number>, line <line number>.	Enter a valid project variable in the field Variable. Use the notation <organization unit name>.<variable name> or, for global variables, <variable name>
4555	Table cell empty, input mandatory: Parameter OD %d, line %d	This field requires an input.
4556	Table cell empty, input mandatory: Variable OD %d, line %d	This field requires an input.
4800	The maximum number of tasks was exceeded. (Any touch probe inputs also count as task).	Delete a task, or remove a touch probe input.
4801	A hardware interrupt to start a task is used more than once.	Check all applied hardware interrupts.
4802	A task identifier is used more than once.	Check all task identifiers.
4803	A task priority has been assigned more than once. Priority 0, Task not active, may be assigned more than once.	Check all assigned priorities.
4804	A digital input is used to start a task (hardware interrupt) and as touch-probe input. An input can be used either to start a task or as TP, not both.	Either delete the TP input, or use a different input to start a task.
4805	Incorrect watchdog time. The watchdog time for a task is 0.	Check the task watchdog times.
4810	The codes stored in the Instance Parameter Manager require too much memory.	Delete some codes.
4811	Several initialization values were assigned to one code. Code initialization must be unique.	Check all initialization values.
4812	Error in the Parameter Manager.	Refer message text for the cause.
4813	A scale function was used in a global function block instance.	Instance function blocks with scale functions locally only.
4820	Error during code initialization value processing.	The device description of the applied automation system was not found.
4850	The applied version of the Drive PLC Developer Studio does not allow the generation of an external library.	Contact Lenze.

15.5.3 Communication errors

No.	Cause	Possible remedy
1 (0001)	Transmit buffer in the controller is full. `CAN_ERR_XMTFULL`	System-oriented communication error 15-22
2 (0002)	CAN controller was read too late. `CAN_ERR_OVERRUN`	
4 (0004)	Bus error: An error counter has reached the limit. Limit. `CAN_ERR_BUSLIGHT`	
8 (0008)	Bus error: An error counter has reached the limit. `CAN_ERR_BUSHEAVY`	
16 (0010)	Bus error: CAN controller assumed CANopen status bus off. `CAN_ERR_BUSOFF`	
32 (0020)	Rcv queue has been read out. `CAN_ERR_QRCVEMPTY`	
64 (0040)	Rcv queue was read out too late. `CAN_ERR_QOVERRUN`	
128 (0080)	Transmit queue is full. `CAN_ERR_QXMTFULL`	
256 (0100)	Register test of 82C200 failed. `CAN_ERR_REGTEST`	
512 (0200)	Problem with VxD localization. `CAN_ERR_NOVXD`	
1024 (0400)	Hardware occupied by the network. `CAN_ERR_HWINUSE`	
2048 (0800)	Network occupied by client. `CAN_ERR_NETINUSE`	
5120 (1400)	Hardware handle was invalid. `CAN_ERR_ILLHW`	
6144 (1800)	Network handle was invalid. `CAN_ERR_ILLNET`	
7168 (1C00)	Client handle was invalid. `CAN_ERR_ILLCLIENT`	
8192 (2000)	Resource (FIFO, client, timeout) cannot be generated. `CAN_ERR_RESOURCE`	
40960 (A000)	General error	Contact Lenze
40961 (A001)	This system bus adapter does not allow the selected function.	Use a suitable system bus adapter. Contact Lenze.
40962 (A002)	No system bus adapter active.	Activate a system bus adapter.
41217 (A101)	Internal program error (NULL pointer).	Restart the application. If the error still occurs, contact Lenze.
41218 (A102)	Bus device read timed out.	Increase the value of parameter Communication timeout for the selected system bus adapter on the Settings tab.
41219 (A103)	Internal program error (invalid network)	Install the CAN driver update. If the error still occurs, contact Lenze.
41220 (A104)	Internal program error (invalid data)	Install the CAN driver update. If the error still occurs, contact Lenze.
41221 (A105)	Internal program error (invalid operation)	Install the CAN driver update. If the error still occurs, contact Lenze.
41222 (A106)	Internal program error Error when reading a data block.	Restart the application. If the error still occurs, contact Lenze.
41223 (A107)	Internal program error (invalid size)	Restart the application. If the error still occurs, contact Lenze.
41224 (A108)	Error when initializing the data download.	Restart the application. Use the system bus configurator to check if the target system responds.
41225 (A109)	Error when initializing the data upload.	Restart the application. Use the system bus configurator to check if the target system responds.
41226 (A10A)	Error during data transfer.	Restart the application. Use the system bus configurator to check if the target system responds.
41227 (A10B)	Incorrect I/O address	Set a valid I/O address for the selected system bus adapter on the Settings tab.

No.	Cause	Possible remedy
41228 (A10C)	Incorrect interrupt	Set a valid interrupt for the selected system bus adapter on the Settings tab.
41229 (A10D)	Incorrect baud rate	Set a valid baud rate for the selected system bus adapter on the Settings tab.
41230 (A10E)	The drivers required for the selected system bus adapter were not found.	Reinstall the drivers for the selected system bus adapter.
41231 (A10F)	The system bus adapter is already used by another application in an incompatible mode.	Close all applications and try again.
41232 (A110)	Error when loading the resources.	Install the CAN driver update. If the error still occurs, contact Lenze.
41233 (A111)	The configuration file could not be loaded.	Reinstall the system bus default configuration.
41234 (A112)	Automation system read error.	Reset the automation system (mains switching) and try again.
41235 (A113)	Error when reading from target system.	Reset the target system (mains disconnection) and try again.
41236 (A114)	The maximum number of supported communication modules (e. g., CAN USB adapters) was exceeded.	Remove one communication module.
41237 (A115)	The installed drivers do not support the selected system bus adapter.	Install a driver update for the selected system bus adapter.
41238 (A116)	A system bus adapter unknown to the system has been selected.	Install a driver update for the system bus adapter to be used.
41239 (A117)	System bus adapter initialization error.	Check that the selected system bus adapter is connected properly to the PC.
41240 (A118)	Error when writing the configuration file.	Reinstall the CAN driver.
41241 (A119)	The format of the configuration file is invalid.	Reinstall the CAN driver.
41242 (A11A)	Several PC system bus adapters 2177 connected to the PC at the same time.	Connect only the PC system bus adapter 2177 to be configured to the PC.
41243 (A11B)	Error during USB device number write to PC system bus adapter 2177.	Check that the system bus adapter is the only PC system bus adapter 2177 and properly connected to the PC.
41244 (A11C)	Error during USB device number read from PC system bus adapter 2177.	Check that the system bus adapter is the only PC system bus adapter 2177 and properly connected to the PC.
41245 (A11D)	The file **LSystembusL1.DLL** could not be loaded.	Reinstall the CAN driver.
41246 (A11E)	he file **LSystembusL1.DLL** could not be loaded.	Install the CAN driver update. If the error still occurs, contact Lenze
41247 (A11F)	The system bus adapter could not be initialized. No free handles available..	Install the CAN driver update. If the error still occurs, contact Lenze
41248 (A120)	The baud rate set for the selected system bus adapter does not match the baud rate of the devices connected to the bus.	Set the baud rate set for the bus devices for the selected system bus adapter on the **Settings** tab.
41249 (A121)	The baud rate set for the selected system bus adapter does not match the baud rate of the devices connected to the bus.	Set the baud rate set for the bus devices for the selected system bus adapter on the **Settings** tab.
41250 (A122)	Internal program error Invalid filter setting.	Install the CAN driver update. If the error still occurs, contact Lenze.
41251 (A123)	The parameter channel to be used is already used by another bus station or by another PC program.	Set another parameter channel for the selected system bus adapter in the **Settings** index of the system bus configurator or ensure that the selected parameter channel is not occupied by another bus station or another PC program.
41252 (A124)	The **LSystembusL2.DLL** file could not be loaded.	Reinstall the CAN driver update.
41253 (A125)	Error when starting the download mode.	Restart the application.
41254 (A126)	Error during program download.	Restart the application.
41255 (A127)	-	-
41256 (A128)	Too many invalid telegrams have been detected on the system bus.	Check the installation of the system bus (terminating resistor, shielding) for the baud rates used.
41728 (A300)	Internal program error OPC item could not be created.	Restart the application.

No.	Cause	Possible remedy
41729 (A301)	Error when writing an OPC item.	Contact Lenze
41730 (A302)	Internal program error OPC item could not be read.	Restart the application. Use the system bus configurator to check if the target system responds.
41731 (A303)	Internal program error OPC connections failed.	Install the CAN driver update. If the problem still exists, contact Lenze.
41732 (A304)	Internal program error OPC connection point for asynchronous communication could not be created.	Install the CAN driver update. If the problem still exists, contact Lenze.
41733 (A305)	Internal program error OPC item could not be deleted.	Restart the application.
41734 (A306)	Internal program error OPC item list could not be deleted.	Restart the application.
45569 (B201)	The target system has an H05 trip. Internal fault.	Contact Lenze.
45570 (B202)	The target system has a PR0 trip. Parameter set error	Reset the trip.
45571 (B203)	The target system has a PER trip. Program failure	Reset the trip. (Mains disconnection)
45572 (B204)	The target system has a CCR trip. System failure	Reset the trip. (Mains disconnection)
45573 (B205)	The target system has an unknown error.	Contact Lenze.
45574 (B206)	The software version of the target system does not correspond to the program to be loaded.	Use the corresponding target system.
45575 (B207)	The target system is write-protected.	Remove the write protection for downloading.
45576 (B208)	Controller is not inhibited in the target system.	Inhibit the controller.
45577 (B209)	PLC program did not stop.	Stop the PLC program.
45578 (B20A)	The program to be loaded is too large for the target system.	Reduce the program size. Split the program.
45579 (B20B)	The target system has not enough technology units.	Use an xT variant as a target system, e.g. EVS93xx-xT.
45580 (B20C)	The preparations for the program transfer have failed.	Reactivate the program transfer. If the problem still exists, contact Lenze.
45581 (B20D)	Error when reading from the target system.	Reset the target system. Then try again.
45582 (B20E)	Error when writing to the target system.	Reset the target system. Then try again.

15.5.4 System-oriented communication error

Note!

System-oriented communication error at the CAN bus

A system-oriented error occurred at the CAN bus.
Please check

- the network hardware
  (connections, cables, terminating resistors).
- the system bus adapters used.
- the configuration settings
  (no double assignment of node addresses, identical baud rates).
- Restart the PC.

15.6 Glossary

Sequential Function Chart	Sequential Function Chart SFC (*Sequential Function Chart - SFC*) is a programming language to describe sequential and parallel control processes with time and event control.
Action	Boolean variable or instructions which can be controlled through an action block (in SFC).
Action block	Activation description of actions in SFC.
Current event	Intermediate result in IL of any data type.
Instruction List	Instruction List (*Instruction List - IL*) is a common programming language for PLC systems similar to Assembler.
SFC	Abbreviation for Sequential Function Chart
IL	Abbreviation for Instruction List
Organization unit	(Sub-)program unit which is part of a PLC program. Often organization units can be loaded into the PLC independently of each other. Compare POU.
CPU	Central processing unit (*Central Processing Unit*) of, e.g., a PLC.
Declaration	Indication of variables and FB instances in a declaration block by also indicating the identifier, data type and FB type as well as initial values, ranges and field features.
Declaration block	Summary of declarations for a variable type at the beginning of a POU.
Elementary data type	A standard data type predefined by IEC 61131-3.
Function extensions	A function can have a variable number of inputs.
FB	Abbreviation for Function Block (*Function Block*), often, function blocks are also called "Function organization units".
FB instance	See Instance
FB type	Name of a function block with request interface.
FBD	*Function Block Diagram*, see Function Block Diagram
Function	A POU of type `Function`
Function organization unit	See Function block
Function block	A POU of type `Function_Block`
Function Block Diagram	The Function Block Diagram (*Function Block Diagram*) consists of a list of networks which enable the user to create graphics that show any program process by means of connection elements.
FBD	See Function Block Diagram
IL	*Instruction List*, see Instruction List
Indirect FB call	Call of an FB instance whose name has been transferred to a POU as `VAR_IN_OUT` parameter.
Instance	Structured data set of an FB by declaration of a function block plus indication of the FB type.
LD	Abbreviation for Ladder Diagram
Configuration	The configuration (*Configuration*) defines the PLC structure and represents the highest level in the IEC 61131-3 software model.
Ladder Diagram	Ladder Diagram (*Ladder Diagram - LD*) is a programming language to describe networks with simultaneously operating Boolean and electromechanical elements such as contacts and coils.
LD	*Ladder Diagram*, see Ladder Diagram
POU	Abbreviation for Program Organization Unit (*Program Organization Unit - POU*)
POU	*Program Organization Unit*, see Program Organization Unit
Program Organization Unit	The Program Organization Unit is an organization unit in IEC 61131-3 of type function, function block or program. It builds up user programs hierarchically.
Resource	A resource (*Resource*) is a central unit (CPU) of a configuration.
Step	Status node in an SFC program. Actions referring to a step are started here.
SFC	*Sequential Function Chart*, see Sequential Function Chart
PLC	Programmable Logic Controller (*Programmable Controller*).

ST	Abbreviation for Structured Text.
Standard functions	All functions predefined by IEC 61131-3 to implement PLC typical functionality.
Standard organization units	See Standard function blocks
Standard function blocks	All function blocks (*Function Blocks*) predefined by IEC 61131-3 to implement PLC typical functionality.
Structured Text	Structured Text (*Structured Text*) is a programming language to describe algorithms and execution control by means of the latest high languages.
Task	Definition of run time features of a program.
Transition	Transition from one SFC step to the next by evaluation of the transition condition.
Type definition	Definition of a user-specific data type based on already existing data types.
Variable	Name of a data memory which can contain values determined by the data type or variable declaration.
Cycle	The cycle of a (periodically called) user program.
Cycle time	The cycle time is the time needed by the user progam for a cycle.

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